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TECHNICAL MANUAL FOR THE MEDIUM THERMO-VACUUM FACILITY

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SCOPE OF MANUAL

This manual is intended to provide the user of the MEDIUM THERMO-VACUUM FACILITY, with the necessary information and procedures to operate and maintain the system.

This manual is to be used with the supporting engineering data pack and catalogue library as indexed in Section 6 of this manual.

SECTION 1

PLANT DESCRIPTION

1. INTRODUCTION

This manual is intended to provide the user with the necessary detail and procedures to operate and maintain the Medium Thermo-Vacuum Facility.

The Medium Thermo-Vacuum Facility is described under the following headings:

- Vacuum Vessel and Support System
- Thermal System
- Vacuum System
- Main Control and Data Acquisition

Where applicable, reference is made to design drawings, diagrams and component manuals. A complete documentation reference index of all component manuals is provided in Section 6 of the manual.

2. VACUUM VESSEL AND SUPPORT SYSTEM(S)

The vacuum vessel and door trolley are shown in drawings VTFM-11000-122 and VTFM-6500-122 respectively.

The vessel is constructed of 304 stainless steel and stands in the clean area of the facility. The internal diameter of the vessel is 1,0m and the total length is 1,42m.

Penetrations are provided in the rear of the vessel for pipes feeding nitrogen to the shrouds. Similarly the front has penetrations for nitrogen and for Dowtherm fluid, which feeds the thermal plate.

Vacuum and instrument penetrations are provided on the circumference of the vessel.

The entire vessel is mounted on an aluminium table. An aluminium trolley (which runs on inverted rails on the table) supports the vessel's door and allows it to be rolled away from the vessel for the experiment to be removed or installed on the thermal plate.

3. THERMAL SYSTEM

3.1 GENERAL, DESCRIPTION

The thermal system comprises of two independent subsystems i.e. the Nitrogen thermal system and the Dowtherm thermal system. These systems are described in more detail in the paragraphs below:

3.2 NITROGEN THERMAL SYSTEM

The nitrogen system comprises of the following main components as depicted in the P&I diagram no VTFM-30000-05:

a) Thermal Generator (refer assembly drawing VTFM-30000-03)

- Nitrogen Injection Vessel (Cooling Unit)
- Heater Unit
- Gas Circulation Fan
- Flashing Chamber
- Top Manifold
- Gas Purge and Pressure Control System

b) Shrouds.

Each of these main components are described in the paragraphs below and an overview of the operating modes are also given:

3.2.1 Thermal Generator

3.2.1.1 Nitrogen Injection Vessel (Cooler Unit)

The Nitrogen Injection Vessel is shown in drawing VTFM-31000-03. The unit is a pressure vessel manufactured from stainless steel, with a stainless steel outer jacket, the cavity being filled with polyurethane foam. Liquid nitrogen is injected by means of a lance through two stainless steel nozzles. The nitrogen flow rate is controlled using a proportionally controlled cryogenic needle valve.

3.2.1.2 Heater

The heater unit is shown in drawing VTFM-31500-03. The unit is a pressure vessel manufactured from stainless steel, with a stainless steel outer jacket, the cavity being filled with polyurethane foam. The heating elements are able to generate 8kW of energy and are controlled by a thyristor drive.

3.2.1.3 Gas Circulation Fan

The circulation fan is shown in drawing VTFM-30500-03. This unit consists of a centrifugal fan, with a water cooling system for the motor. The motor and fan are inside the pressure system. The motor is a standard flanged mounted type, and the fan casing, shaft and impeller are manufactured from stainless steel, with an outer jacket of stainless steel; the cavity being filled with polyurethane foam. The water inlet to the cooling coil system is fitted with a solenoid valve, and the outlet with a paddle switch . A thermocouple to monitor the electric motor temperature is fitted on the motor casing and the sensing wire is routed through the main flange of the fan pressure housing.. The fan speed is controlled using a variable speed drive.

3.2.1.4 Flashing Chamber

The flashing chamber is shown in the assembly drawing VTFM-31000-03 The liquid nitrogen level in the vessel is controlled by measuring the liquid head with a differential pressure transmitter, which operates the liquid nitrogen injection control valve. The valve is a cryogenic needle type, with proportional control.

3.2.1.5 Top Manifold

The top manifold is shown in the assembly drawing VTFM-30000-03. The unit is a 4 inch stainless steel pipe with a stainless steel outer jacket, the cavity being filled with polyurethane foam. This unit is connected to the following

- The gas circulation fan
- The gas purge and pressure control system
- Two cryogenic ball valves, connected to the pipework leading from shroud outlets.

3.2.1.6 Gas Purge and Pressure Control System

This system consists of a number of valves on a stainless steel T-piece which is connected to the top manifold. These valves are as follows:

- Pressure control valve - this is a proportionally controlled needle valve which is used to maintain the thermal system pressure at a predetermined level.

- Manual valve - this is a manual ball valve which can be used to depressurize the thermal system manually.

- Safety relief valve - this valve is set at 6,5 bars (gauge). This will open and maintain the system pressure below safety limits in the unlikely event of a failure of the pressure control system

3.2.2 Shrouds

There are three shrouds in the vessel and they are depicted in drawing no VTFM-10000-03. One shroud is cylindrical and covers the length of the vessel. Two shrouds are disc shaped and cover the front door and rear dome of the vessel. The cylindrical and rear shrouds are interconnected with pipe work and form one integral unit. The shrouds are constructed of stainless steel and provide for a working space of 0,7m inside diameter and length of 0,9m.

The shrouds consist of outer and inner stainless steel plates with a space in-between in which the gaseous or liquid nitrogen is contained and circulated.

The cylindrical rear shroud unit is provided with four support lugs, two at the front end and two at the rear end. The lugs in turn are supported by longitudinal rails which in turn are attached to the vessel inside wall by brackets. Teflon bearings are attached to the support lugs to provide a smooth movement when the shroud is inserted, removed or when it expands or contracts during thermal cycling. The door shroud is attached to the door in such a way as to allow free thermal expansion and contraction.

Nitrogen is applied to the shrouds through stainless steel feeder pipes. Small diameter stainless steel pipes connect the shroud inner spaces to the feeder pipes.

3.3 DOWTHERM THERMAL SYSTEM

The dowtherm thermal system comprises of the following main components as depicted in the assembly drawing no VTFM-70000-03:

- Dowtherm Assembly
- Thermal plate.

Dowtherm fluid is circulated by means of pump P100 from a temperature control tank. The temperature of the fluid in the tank is increased by electrical heater EH 100, powered by means of a thyrister drive and controlled by a PLC. The temperature is lowered by injecting liquid nitrogen into the liquid. Proportional control valve V115 admits the liquid nitrogen into the tank and the gaseous nitrogen which forms, escapes at the top of the tank to atmosphere. Valve V115 is controlled by a PLC. The stirrer S100 ensures that the Dowtherm J fluid does not crystallise at liquid temperatures to as low as -80°. The Dowtherm system is schematically presented in diagram no VTFM-30000-05.

In case the Dowtherm J-fluid has to be drained from the thermal plate and piping inside the vessel, gaseous nitrogen is admitted by the connecting pipe provided for this purpose on the downstream side of isolation valve V120 which, in such an event, is closed. An non-return valve is fitted in the pipe line to prevent the pump from "blowing" empty.

The Dowtherm pipe penetrates the vessel through the door. The feed and return lines are flexible and can move freely when the door is opened or closed. It is thus unnecessary to uncouple these pipes during or prior to any operational mode. Flexible pipe sections are provided inside the vessel to compensate for thermal expansion and contraction.

3.3.2 Thermal Plate

An aluminium thermal plate is provided inside the chamber onto which units under test can be mounted. The plate is provided with internal channels through which the heat transfer fluid, Dowtherm J, is circulated. Details of the thermal plate is depicted in drawing no VTFM-10035-122.

The temperature of the thermal plate is controlled by controlling the temperature of the fluid. The thermal plate provides for control between +80°C and -80°C with a transient rate of 2°C/minute. The temperature homogenity on the plate surface is smaller than 2°C during any operational mode.

3.4 OPERATING MODES

3.4.1 General

The cryogenic fluid used is nitrogen, both in liquid and gaseous phases. There are two modes of operation, namely:

1) Gaseous mode

   Gaseous nitrogen at seven bars (absolute) is recirculated through the shrouds by the gas circulation fan and the nitrogen gas is cooled or heated externally to the test vessel by the cooler and heater units respectively. The shroud temperature in this mode is controllable from 393 K to 123 K with a transient rate of 1.5° K/minute.

2) Liquid (flooded) mode

In this mode, liquid nitrogen is forced into the shrouds and removes the heat from the shrouds by boiling at atmospheric pressure. This mode is "uncontrolled" with shroud temperatures in the region of 78→88^{O} K.

The spreadsheets of the thermal systems "designed performances" can be found in the Performance Specification document no: VTFM-00000-62/2.

3.4.2 Gaseous Mode

The system must initially be flushed with gaseous nitrogen (valve V121 and V127) to remove air and water vapour from inside the thermal system pressure boundary.

In operation, the nitrogen gas is recirculated by the centrifugal fan (RF100) which has a variable speed motor . To eliminate seal problems, the fan and motor are both encased in a pressure vessel. The fan speed is controlled to ensure specified mean temperature difference across the shrouds, (< 3^{O} K at steady state, and< 7,5^{O} K during transient).

The nitrogen stream is cooled by injecting liquid directly into the gas flow (Cu100), and heating by electrical elements in the gas stream (HU100). The injectors and heaters are controlled by measuring of the gas stream temperature before entering the shrouds. Flow through the different shrouds can be balanced by valves V101 to V102.

3.4.3 Liquid Mode

The system is filled with liquid nitrogen from the bulk storage tank until the liquid covers the shrouds completely. The level is maintained at a level inside the flushing chamber (through valve V109). As the liquid boils, the gas is vented to atmosphere (through valve V135).

In this mode of flooding, the shroud wall temperatures should stabilise at or lower than 88K.

3.5 THERMAL CONTROL AND INSTRUMENTATION SYSTEM

The control of the thermal system is achieved using a Telemecanique PLC in which a number of dedicated PID loops reside. The thermal control may be broken down into the following sub-sections:

3.5.1. FAN CONTROL.

The fan speed is a function derived directly from the temperature of the gas stream measured below the heater unit HU100. The colder the gas the slower the fan will turn. The warmer the gas, the faster the fan will turn.

3.5.2. HEATER AND COOLER CONTROL.

Both the heater and the cooler are controlled by dedicated PID loops. The required setpoint is input to the PID loop and the process variable is selected from the probes attached to the shrouds. When the system is heating, the system will select the highest temperature as the process variable, and when the system is cooling, the system will select the lowest temperature.

During a transient, the setpoint for the system is automatically increased at a rate of 1,5 degrees per minute until the required system temperature is reached.

3.5.3 SHROUD CONTROL.

The door and rear shrouds are both fitted with one (1) PT100, in the centre of the disks. The cylindrical shroud is fitted with two (2) PT100's, one ~~Fitted to each shroud is a balancing valve and one (1) PT100 probe.~~ Hand valves manually each on the inlet balance ~~each shroud~~. and outlet manifold the door and cylindrical shrouds (combination) and the rear shroud are manually balanced with valves V101 and V102.

3.5.4 PRESSURE CONTROL.

A Pressure sensor PS100 is fitted to the system and the output of the transducer is input to a Shimanden Loop Controller and to the PLC. The output of the loop controller is connected to valve V106 the pressure control valve. When the system pressure approaches the setpoint level (Approximately 7 Bar absolute) the loopcontroller will open valve V106 proportionally and thus control the system pressure. If the system pressure rises above 7,5 bar absolute, the PLC will automatically close the nitrogen inlet valve and open the drain valve to prevent over-pressurisation.

3.5.5 FLASHING CHAMBER CONTROL.

A Pressure sensor PS101 is fitted to the flashing chamber and the output of the transducer is input to a Shimanden Loop Controller and to the PLC. The output of the loop controller is connected to valve V109 the flashing chamber inlet control valve. When the flashing chamber level approaches the setpoint level (Approximately ~~2-3 meters~~ water) the loop controller will close valve V109 proportionally and thus control the flashing chamber level.

200 – 300 mm

4. VACUUM SYSTEM

4.1 INTRODUCTION

Drawing VTFM-20000-05 depicts the schematic diagram of the vacuum system. The numbering of the various components in the text is as per this drawing.

The vacuum system consists of two separate pumping modules, namely:

- Module One - "Fore-vacuum pumping" system
- Module Two - "High-vacuum pumping" system.

In the following paragraphs each of the modules and its related control system are described in more detail.

4.2 FORE-VACUUM PUMPING SYSTEM

This is a two-stage rotary pumping comprising of:

- One D40B two stage oil sealed rotary vane pump (P3). A complete technical description of this pump is given in document VTFM-20000-128-01/1.

- One WSU 151 single stage Roots pump (P2). A complete technical description of this pump is given in document VTFM-20000-128-02/1.

The fore-vacuum pumping system discharges through an oil exhaust filter (EF1) into the process area.

The interconnection of the pumps is shown in drawing VTFM-20000-05, and as shown the system is connected to the vacuum vessel through valve V3.

4.3 HIGH-VACUUM PUMPING SYSTEM

The high vacuum pumping system consists of:

- A type RPK 1500 U3.cryogenic pump (P1) with a pumping speed of 1500.l/s Complete technical descriptions of this pump with cold head, is given in documents VTFM-20000-128-03/2.

- A helium compressor unit (HC1), for the cryogenic refrigeration of the cold head. A complete technical description of this unit is given in document VTFM-20000-128-03/2.

The discharge of this pump, during the regeneration cycle is through a sorption trap ST1 into the suction side of the fore-vacuum system.

The cryogenic pump is connected through valve V1 to the vessel.

4.4 THE VACUUM CONTROL AND INSTRUMENTATION SYSTEM

4.4.1 General

A PLC is used for the remote control of the various modules and to capture data measured at various points in the vacuum system.

4.4.2 Fore-vacuum pumping system

The fore-vacuum is measured by Pirani heads PH1 and PH2. These measuring heads read into a Combitron 351 instrument. A complete technical description of the Combitron CM 351 is given in document VTFM-20000-128-08/3.

4.4.3 High-vacuum Pumping System

4.4.3.1 Vacuum Measurement

A Pirani head PH1 as previously described and a Penning head (Thermovac) PEH1 are installed directly onto the vessel. The Penning head is also read into the Combitron instrument.

4.4.3.2 Vacuum Pump Control

(1) Cryogenic pump temperature measurement.

The temperature of the cold head of the cryogenic pump is measured by a Cryotherm low temperature instrument (LTI1). A technical description of this instrument is given in document VTFM-20000-128-06/1.

(ii) Cryogenic pump regeneration control

A regeneration heater control unit (RHC1) is used for supplying power to, and controlling the electric regeneration heaters of the cryogenic pump. A technical description of this unit is given in document VTFM-20000-128-05/1. The heaters are installed directly at the refrigerating surfaces of the cold heads. Regeneration is controlled ~~either locally or remotely using the PLC~~ manually controlled via the heater control unit.

4.4.4 Residual Gas Analyser

The Residual Gas Analyser (RGA) analyses the rarefied atmosphere in the vacuum vessel. The instrument consists of a sensor which functions only in the high vacuum environment ($< 1 \times 10^{-5}$ m Bar) and electronic unit which operates the sensor and display its output. The sensor analyses the residual gases by ionising some of the gas molecules, separating the resulting ions according to their respective masses, and measuring the quantity of ions at each mass. The masses of the various ions/species (produced by the sensor) are used to identify the gas molecules from which they were created; the magnitudes of these signals are used to determine the quantities of the respective species.

The information produced by the RGA is an important aid in the efficient use of the high vacuum system for example, indicating the presence of a leak or contaminant in the vacuum atmosphere.

The measuring sensor consists of three parts, namely:

- The ion source (ionizer),
- the analyser (ion filter);
- and the ion detector.

The sensor is mounted on a flange which in turn is bolted to an access port at the rear vessel. -A complete technical description of the RGA is given in document VTFO-20000-128-36/1 and 2.

5. MAIN CONTROL AND DATA ACQUISITION SYSTEM

5.1 GENERAL

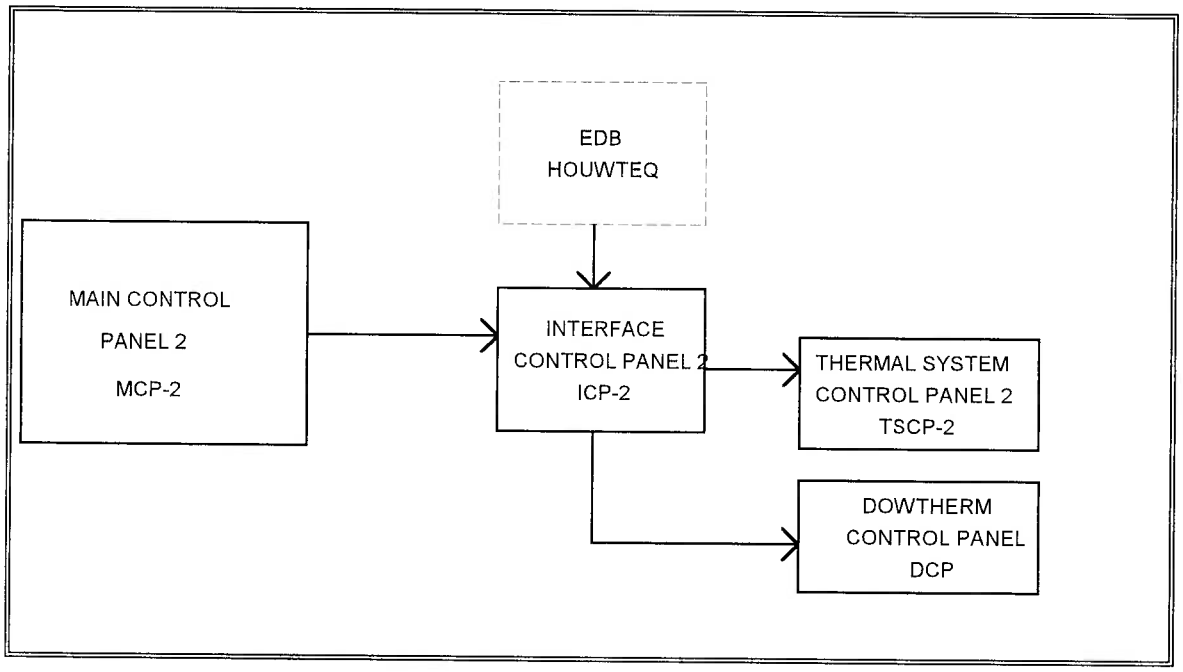
In the description of the thermal and vacuum systems brief mention was made of PLC control. This section provides a more detailed description of the PLC network which provides control and data acquisition.

The following functions are supported by the PLC:

- Generation of discrete output signals
- Processing of discrete input signals

- Flow control of coolant
- Control of PID loops
- Measurement of temperature
- Measurement of pressure (vacuum

The interface between the Main Control Panel and other sub-systems, are shown in the block diagram 1 below:



BLOCK DIAGRAM 1: CONTROL PANEL INTERFACE LAYOUT

5.2 SOFTWARE

5.2.1 Computer

The computer will be driven by a number of software packages namely:

OS/2: This operating system will reside on the computer. This software is described in document VTFO-40000-128-05/1 and 2.

X-tel (PL7.3): This program will be used to program the PLC. It is important to note that the PLC chosen allows on line changes to the program while the PLC is executing the program. This facility must be distinguished from the feature where set points are altered. This software is described in document VTFO-40000-128-17/1.

5.3 HARDWARE

5.3.1 Programmable Logic Controller (PLC)

All the PLC cards are located in the PLC card frames. The following modules are located in the card frames:

Power supply	The power supply supplies power to the cards located in the PLC card frame. The power supply specifications are listed in the TSX SUP 70 manual document VTFM-40000-128-10/1.
Processor Module	The PLC program is stored and executed by the processor module type TSX 67-40. Installation and user instructions are detailed in document VTFM-40000-128-06/1.
Discrete Input Card	The discrete input lines are monitored and read by the 32 channel discrete input card type DET 32 12. Installation and user instructions are detailed in document VTFM-40000-128-16/1 (TSX DET 32 12 32 input module pamphlet).
Discrete Output Card	The discrete output lines are controlled by the 32 channel discrete output card type DST 3292. Installation and user instructions are detailed in document VTFM-40000-128-15/1 (TSX DST 3292 Interface Output Module pamphlet).
Analog Input Module	The analogue input signals are processed by the AEM 81 8 channel analogue input module. Installation and user instructions are listed in document VTFM-40000-128-09/1 (TSX D23 001E Analogue Input Module).
LRX 100 Transmitters	The PT 100 temperature signals are processed by the LRX 100 loop powered transmitters. The 4-20 mA signal is input to an AEM 811 8 channel analogue input module. Installation and user instructions are listed in document VTFM-40000-128-09/1 (TSX D23 001E Analogue Input Module).
ASR 402 Analogue Output Card	Analogue signals are processed by the 4 channel ASR 402 analogue output card. Installation and user instructions are listed in document VTFM-40000-128-13/1 (TSX D23 001E Analogue Input Module).
Serial Communication Card	Serial communication signals are processed by the 2 channel serial communication card SCM2011. Installation and user instructions are listed in document VTFM-40000-128-07/1 (TSX D43 724 and TSX D23 004E SCM Users Manuals)

5.3.2 Computer

Computer	The computer used is a 40MHz 386 with 8 megabytes of RAM, one 102 megabyte hard disk, one 1,2 megabyte floppy drive and one 1,44 megabyte stiffy drive The PC is used to program the PLC. Document VTFM-40000-128-01/1 contains the owner

	manual and reference guides (386-25/33 AT Compatible Micro computer Handbook volumes 1 and 2).
Hard Disk Adapter	A high performance 16 bit ATA Floppy/Embedded Hard Disk Adapter is located in the computer. Document VTFM-40000-128-02/1 details the operating instructions and also contains the reference guides).
Graphics Adapter	A viewpoint NI VGA graphics adapter is located in the computer. Document VTFM-40000-128-03/1 details the operating instructions and also contains the reference guides (EV-633 Version 1.0).
Serial Mouse	A Microsoft Serial Mouse is connected to the serial port of the computer. Document VTFM-40000-128-04/1 describes the operations and installation of the serial mouse.,

5.3.3 Interface Control Panel

The interface control panel (ICP) is used to connect the PLC discrete signals to the system. The unit functions primarily as a voltage interface and distribution unit. Signals received from the PLC are fuse protected and then either fed directly to the system (24V DC) or control relays and contactors from where the signals are fed to the system. Signals received from the system pass through the ICP where they are fuse protected before being input by the PLC.

The main supply voltages for all the vacuum and thermal system components are switched, isolated and protected via the ICP.

SECTION 2

SPECIFICATIONS

1. INTRODUCTION

This section provides the specification data for all major components of the Medium Thermo Vacuum Facility.

The specifications of the vacuum system, vacuum vessel, thermal system and main control & data acquisition system.

The specifications are given in these tables are for quick reference purposes of the systems, sub-systems and components.

Please note that these tables are not complete in referring to each and every sub-component, etc., but rather concentrate on the overall picture.

The tables are given in the following order:

1. Vacuum System
2. Vacuum Vessel and Pallet
3. Thermal System
4. Main Control and Data Acquisition System

SPECIFICATIONS FOR THE MEDIUM THERMO-VACUUM FACILITY

VACUUM SYSTEM

NO	COMPONENT	ITEM	MODEL	DIMENSIONS/ MASS	SUPPLIER	CAPACITY
1	PRE-EVACUATION PUMPING SYSTEM	1.1 P3 Trivac Rotary Vane Vacuum Pump	D40B	68 kg	Leybold	Nominal pumping speed 46 m^3h^{-1} Max pumping speed with back-up pumps 40 m^3/h Ultimate total pressure <5 x 10^{-3} mbar Motor: single phase 220V 1500W
		1.2 P2 Roots Vacuum Pump	WSU151	90 kg	Leybold	Nominal pumping speed 153 m^3/h Maximum pumping speed with back-up pumps 130m^3/h Maximum admissible differential pressure 130 mbar
2	ULTRA HIGH VACUUM PUMPING SYSTEM	2.1 P1 Cryopump	RPK 1500 U3	Weight 15 kg Height 540 mm	Leybold	Pumping speed 1500 //s
3	PRESSURE MEASURING & CONTROLLING INSTRUMENTS	3.1. Combitron Instrument	CM351		Leybold	See Catalogue VTFO-20000-128-08/1
		3.2. Penning Head	PR35			5 x 10^{-8} to1 x 10^{-2} mbar
		3.3. Perani Thermo-vac Head	TR301			1 x 10^{-3} to 1000 mbar
		3.4. Thermovac	TM321			See Catalogue VTFO-20000-128-19/1

SPECIFICATIONS FOR THE MEDIUM THERMO-VACUUM FACILITY

THERMAL SYSTEM						
COMPONENT	**ITEM**		**MATERIAL**	**DIMENSIONS/MASS**	**TYPE**	**CAPACITY/CHA-RACTERISTICS**
1. GAS CIRCULATION FAN (CANNED TYPE)	1.1	Pressure vessel	304 S/S	Length 653 mm Diameter 508 mm	ASME 8 DIV 1	
	1.2	Insulation	Polyurethane	Thickness 144 mm		
	1.3	Outer Jacket	304 S/S	Length 682 mm Diameter 800 mm		
	1.4	Cooling	304 S/S		Parallel flow - once through type. Water cooled safety inter-locks (flow and tem-perature)	
	1.5	Electrical Motor			Leroy Somer	2,2 kW; 2 pole, 380V controlled by a variable speed drive controller
2. HEATER UNIT	2.1	Pressure vessel	304 S/S	Length 788 mm Diameter 140 mm	ASME 8 DIV 1	
	2.2	Insulation	Polyurethane	Thickness 105 mm		
	2.3	Outer Jacket	304 S/S	Length 854 mm Diameter 350 mm		
	2.4	Heating elements		Quantity 4		8 ~~40~~ kW total

X

SPECIFICATIONS FOR THE MEDIUM THERMO-VACUUM FACILITY

THERMAL SYSTEM						
COMPONENT	**ITEM**		**MATERIAL**	**DIMENSIONS/MASS**	**TYPE**	**CAPACITY/CHA-RACTERISTICS**
3. COOLER UNIT	3.1	Pressure vessel	304 S/S	Length 713 mm Diameter 140 mm		
	3.2	Insulation	Polyurethane	Thickenss 103 mm		
	3.3	Outer Jacket	304 S/S	Length 854 mm Diameter 350 mm		
	3.4	Spray System	304 S/S	Quantity 2	Hollow Cone	
	3.5	Injection valve		½ inch	Proportional needle Pneumatic (Baumann)	7,5 kW 0,015 kg/s
4. FLASHING CHAMBER	4.1	Pipe	304 S/S	Length 1474 mm Diameter 114 mm		
	4.2	Insulation	Polyurethane	Thickness 95 mm		
	4.3	Outer jacket	304 S/S	Length 1474 mm Diameter 300 mm		
5. GAS PURGE AND PRESSURE CONTROL SYSTEM	5.1	Gas Purge valve		3/8 inh	Solenoid valve (supplied by Ascoreg)	
	5.2	Pressure Control valve		1 inch	Proportional Pneumatic ball valve (Worcester)	
	5.3	Safety relief valve		1 inch	Proportional Pneumatic needle valve (Baumann)	

SPECIFICATIONS FOR THE MEDIUM THERMO-VACUUM FACILITY

THERMAL SYSTEM						
COMPONENT	**ITEM**		**MATERIAL**	**DIMENSIONS/MASS**	**TYPE**	**CAPACITY/CHA-RACTERISTICS**
6. SHROUDS	6.1	Disk (door)	304 S/S	Diameter 930 mm	Hydraulic formed waver welded structure (HWW-type)	+ 120°C to -195°C 6 bar (abs) working pressure
	6.2	Disk (back)	304 S/S	Diameter 760 mm		
	6.3	Cylindrical	304 S/S	Diameter 760 mm Length 820 mm		
	6.4	Feeder tubes	304 S/S	Diameter 1/2 inch		
	6.5	Feeder pipes	304 S/S	Diameter 2,5 inch		
7. DOWTHERMAL SYSTEM	7.1	Thermal plate inside the vacuum test vessel	Aluminium	600 x 456 x 20 mm	Internal flow channel	-80°C to +90°C 100 kg load carrying capasity
	7.2	Dowtherm storage tank	304 S/S	Volume: 100 to 200 liters	Open to atmosphere	
	7.3	Heater		Heater elements: Quantity 6	Direct contact elements mounted inside Dowtherm tank, controlled by Thyrister controler	14 kW Dowtherm volume temp. change = 1½ to 2°C/min depends on the level (quantity) of Dowtherm fluid
	7.4	Cooling system (LN_2 injection)			Direct LN_2 injection into Dowtherm.LN_2 injection controlled by Proportional controlled needle vavle	Max 0,03 kg/sec; 15kW. Dowtherm volume temp change rate = 1½ to 2°C/min

SPECIFICATIONS FOR THE MEDIUM THERMO-VACUUM FACILITY

VACUUM VESSEL					
COMPONENT	**ITEM**	**MATERIAL**	**DIMENSIONS/MASS**	**TYPE**	**CAPACITY/CHA-RACTERISTICS**
1. VACUUM VESSEL		304 S/S	a. Inside diameter: 1010 mm b. Total length including the domes 1423 mm c. Volume: ± 1,015 m^3 d. Weight: ± 300 kg	Designed and build in accordance with ASME 8 DIV 1 & ADD 90	a. Polished inside surface b. Glass beat outer surface c. Better than 5 x 10^{-6} mbar

SPECIFICATIONS FOR THE MEDIUM THERMO-VACUUM FACILITY

MAIN CONTROL AND DATA ACQUISITION SYSTEM						
NO	COMPONENT	ITEM	MODEL	DESCRIPTION	SUPPLIER	SPECIFICATION
		Refer VTFM -42000-08				
1	PLC CPU UNIT	11	TSX 67420	PROCESSOR UNIT	TELEMECANIQUE	2048 I/0 V4 PLC
2	PLC PSU UNIT	11	TSX SUP702	POWER SUPPLY	TELEMECANIQUE	5VDC + 24VDC
3	PLC RACK UNIT	11	RKN 82	8 SLOT RACK UNIT	TELEMECANIQUE	8 SLOT RACK
4	OUTPUT CARD	20	TSX ASR 402	4-20 mA 4 CHANNEL	TELEMECANIQUE	4 CHANNEL 4-20 mA OUTPUT CARD
5	INPUT CARD	21	TSX AEM 811	ANALOG 8 CHANNEL	TELEMECANIQUE	8 CHANNEL 4-20mA INPUT CARD
6	INPUT CARD	22	TSX DET 3212	DISCRETE 24 VDC	TELEMECANIQUE	32 CHANNEL 24 VDC INPUT CARD
7	OUTPUT CARD	23	TSX DST 3292	DISCRETE 24 VDC	TELEMECANIQUE	32 CHANNEL 100 mA 24 VDC OUTPUT CARD
8	SERIAL CARD	19	TSX SCM 2011	2 CHANNEL RS232	TELEMECANIQUE	2 CHANNEL RS232 COMMUNICATION CARD
9	TERMINAL	14	XBTVB	OPERATOR DIALOG	TELEMECANIQUE	TERMINAL WITH SINGLE LINE DISPLAY
10	MONITOR	13	BT-H1450Y	RGB/VIDEO MONITOR	NATIONAL	RGB,PAL,NTSC,SECAM VIDEO MONITOR
11	LRX PT100	18	LRX -200 TO 200	3 WIRE PT100 TX	EMMANUEL ELEC.	3 WIRE PT100 4-20 mA TRANSMITTER
12	SDIO CARD	16	IAL4-00014	24 PIN I/O CARD	IST	24 CHANNEL OUTPUT AND INPUT CARD
13	PSU 24 VOLT	15	VTFM-42035	24 VOLT PSU	IST	24 VDC AT 2 AMP
14	RELAY	17	EMG 10-KSR	24V RELAY	PHOENIX	24V COIL, 6 AMP CONTACTS
15	HU100	2	HU1	HEATER UNIT	LEYBOLD	42VAC 1ST STAGE, 24VAC 2ND STAGE
16	COMBITRON	3	CM351	VACUUM INST.	LEYBOLD	2 PERANI HEADS, 1 PENNING HEAD AND SERIAL PORT
17	CRYOTHERM	4	LTI10	TEMPERATURE INST	LEYBOLD	TYPE "D" SILICON DIODE
18	PC	5	EVEREX 386	COMPUTER	HP	386 33 MHZ, 8 MEG RAM, 102 MEG HD
19	MONITOR	6	HP	VGA SCREEN	HP	640*480 RESOLUTION

SPECIFICATIONS FOR THE MEDIUM THERMO-VACUUM FACILITY

MAIN CONTROL AND DATA ACQUISITION SYSTEM						
NO	**COMPONENT**	**ITEM**	**MODEL**	**DESCRIPTION**	**SUPPLIER**	**SPECIFICATION**
		Refer VTFM -45000-08				
20	FAN DRIVE	13	VARISPEED 3KW	3KW VARIABLE SPEED	VARISPEED	3KW 4-20mA 0 TO 6000 RPM
21	HEATER UNIT	2	PHASECON 8KW	8KW THYRISTOR	PHASECON	8KW 4-20mA
22	ITP CONVERTER	1	4-20mA,20-100KPA	I TO P CONVERTER	EMMANUEL ELEC.	IPT/4-20mA/20-100KPA/20PSI/12-28VDC/FA3[DIN]
23	PID CONTROLLER	14	SHIMANDEN SR24	PID LOOP CONTROLLER	N.I.C.	SR24
24	PID CONTROLLER	15	SHIMANDEN SR24	PID LOOP CONTROLLER	N.I.C.	SR24
		Refer VTFM -44000-08				
25	HEATER UNIT	16	PHASECON 12KW	12KW THYRISTOR	PHASECON	12KW 4-20mA
26	PRESSURE SWITCH	25	0-10 BAR	OVER PRESSURE TRIP	ASCO	OVER PRESSURE DETECTION
27	CURRENT SENSOR	8	PRESET 0.75 KW	OVER CURRENT TRIP	BRUBIN ENG.	OVER CURRENT PROTECTION PRESET AT .75KW
28	SOLENOID	7	24V AIR SOLENOID	AIR CUT-OFF VALVE	ASCO	1/4 INCH AIR CUTOFF SOLENOID
29	CUT-OUT RELAY	22	DRI-CUT	CUT-OUT RELAY	BRUBIN ENG.	CUT-OUT RELAY

SECTION 3

OPERATING INSTRUCTIONS

1. PREPARATION PRIOR TO OPERATION

1.1 GENERAL

When the Thermal-Vacuum System (TV-system) was completely switched off and the door was in an open position for some time, this procedure must be followed prior to operation of the system. One also assumes that the test equipment is already placed inside the test chamber, and that all signal/control wires to the experiment are coupled and that electrical feed-throughs are vacuum tested.

The pre-operational activities can be devided into "Test Chamber Preparation" and "Control System Start-up".

1.2 TEST CHAMBER PREPARATION

1.2.1 Make sure that the test piece is locked inside the vessel.

1.2.2 Clean the door and vessel flanges thoroughly with Proponol.

1.2.3 Clean the O-Ring on the Vessel flange carefully with Proponol; make sure no solid particles are collected on the O-Ring.

1.2.4 Unlock door securing pins and close the door, make sure the door and vessel flanges meet correctly.

1.2.5 Use all four door clamps to clamp the door against the vessel flange.

WARNING: **Once the vacuum inside the vessel is better than 200 m.bar. (Pressure < 200 m.bar), the door clamps must be released .**

1. 3 CONTROL SYSTEM START-UP

The "Start-up" of the control system is done at the Main Control Panel (MCP-2). The detail procedure is described in paragraph 7 of this section, "Medium System Operators Dialogue".

2. VACUUM SYSTEM

This paragraph describes the evacuation (pump-down, de-vacuation (turn-off) and regeneration (of cryopumps) procedures and instructions (See D & F diagram appendix 1).

NB
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2.1 EVACUATION

Once the test chamber is prepared and ready for evacuation, the pump-down sequence may begin.

2.1.1 General Description of Evacuation Sequence.

The evacuation sequence/procedure can best be described by the flow diagram 1, "Evacuation Control Logic Diagram".

2.1.2 Operators Instruction

Follow the evacuation steps as described in paragraph 7 of this section "Operators Dialogue".

Before commencing the pump down cycle check for communication between the PLC and the condition and the PLC and the cryo Regen unit (Cryotherm). as follow:-

(1) Rcheck cryo temp on Cyotherm and on Mimic. (F11 ; F9) If temperatures are not the same there is no communication.

(2) Check also lights on ~~units~~ units in bench under table top : lights on two units on the right, without front covers (IST units) should light up alternately.

(3). Pres the REM F on the condition. On release the bar ▬ should go out and come back again.

If Not

Panic abort system to reset the system. The communication should now be reparied

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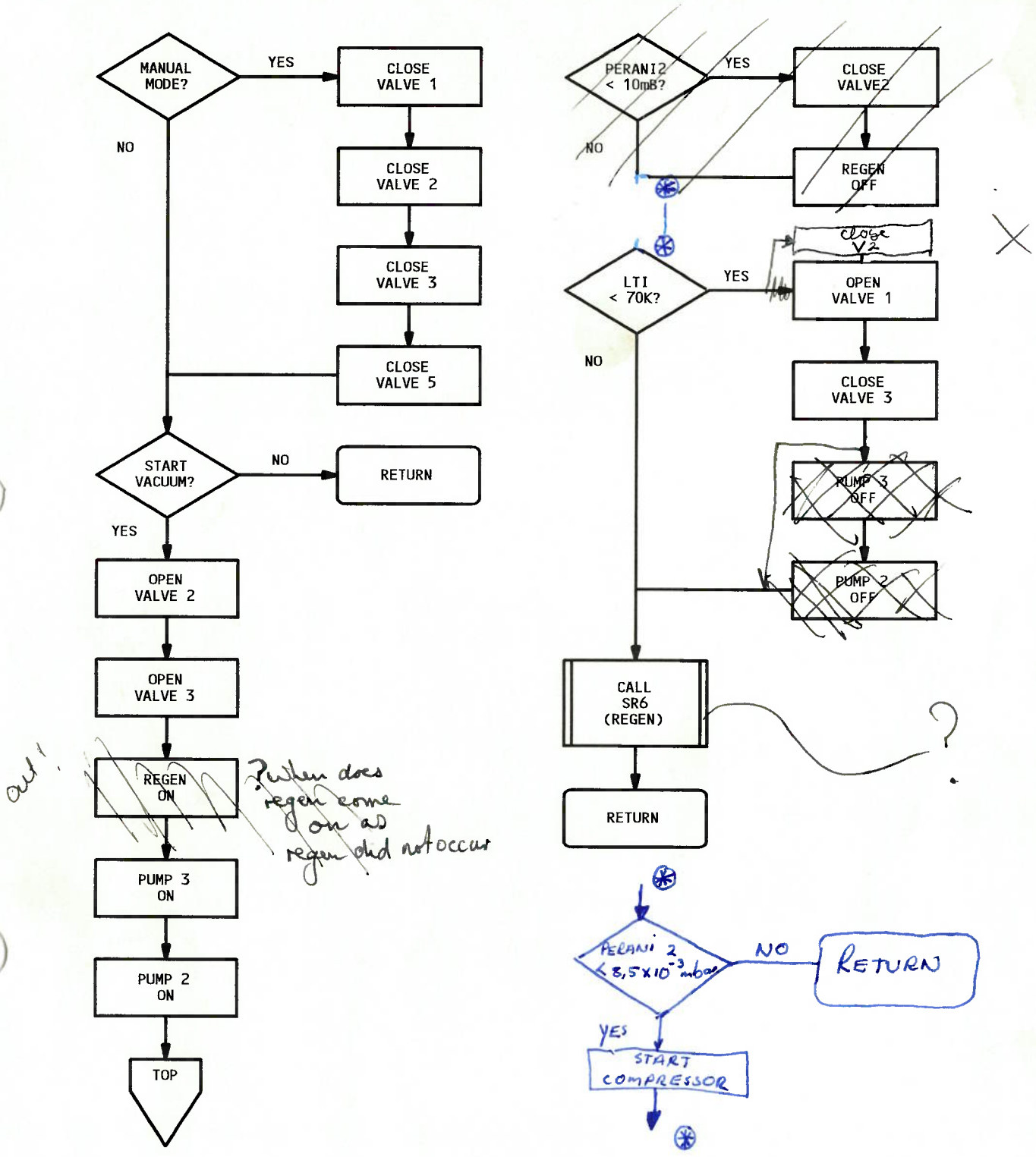


Flow Diagram 1- Evacuation (Pump-down) Control Logic Diagram

2.2 DE-VACUATION

When de-vacuation is required, the sequence detailed below should be followed.

2.2.1 General Description of De-vacuation Sequence

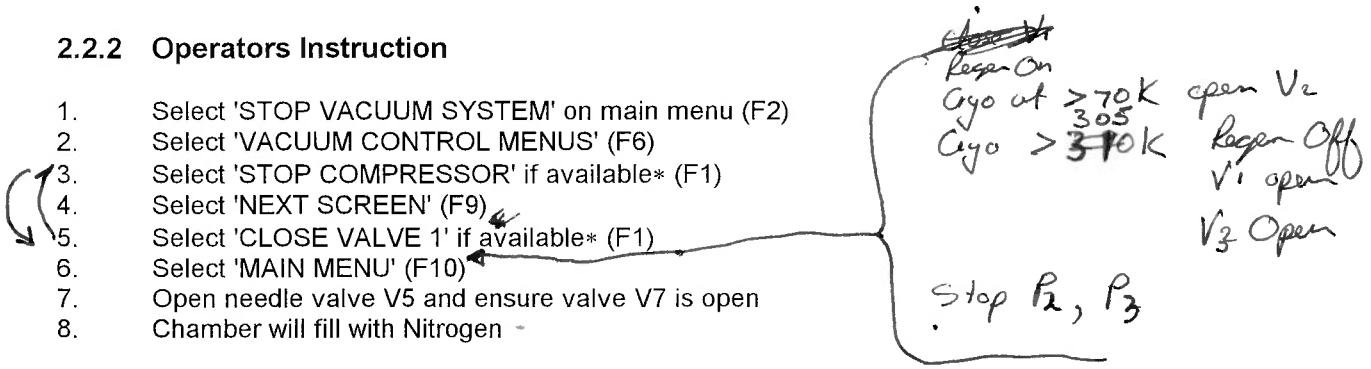
The de-vacuation sequence is a manual sequence that is initiated by the operator.

Before the de-vacuation sequence is started, both the thermal system and the dowtherm system should be switched off, and at room temperature or higher to prevent condensation from forming in the chamber and on the test piece.

Once the dowtherm and thermal system are off, the operator can stop the vacuum system as described below:

2.2.2 Operators Instruction

1. Select 'STOP VACUUM SYSTEM' on main menu (F2)
2. Select 'VACUUM CONTROL MENUS' (F6)
3. Select 'STOP COMPRESSOR' if available* (F1)
4. Select 'NEXT SCREEN' (F9)
5. Select 'CLOSE VALVE 1' if available* (F1)
6. Select 'MAIN MENU' (F10)
7. Open needle valve V5 and ensure valve V7 is open
8. Chamber will fill with Nitrogen



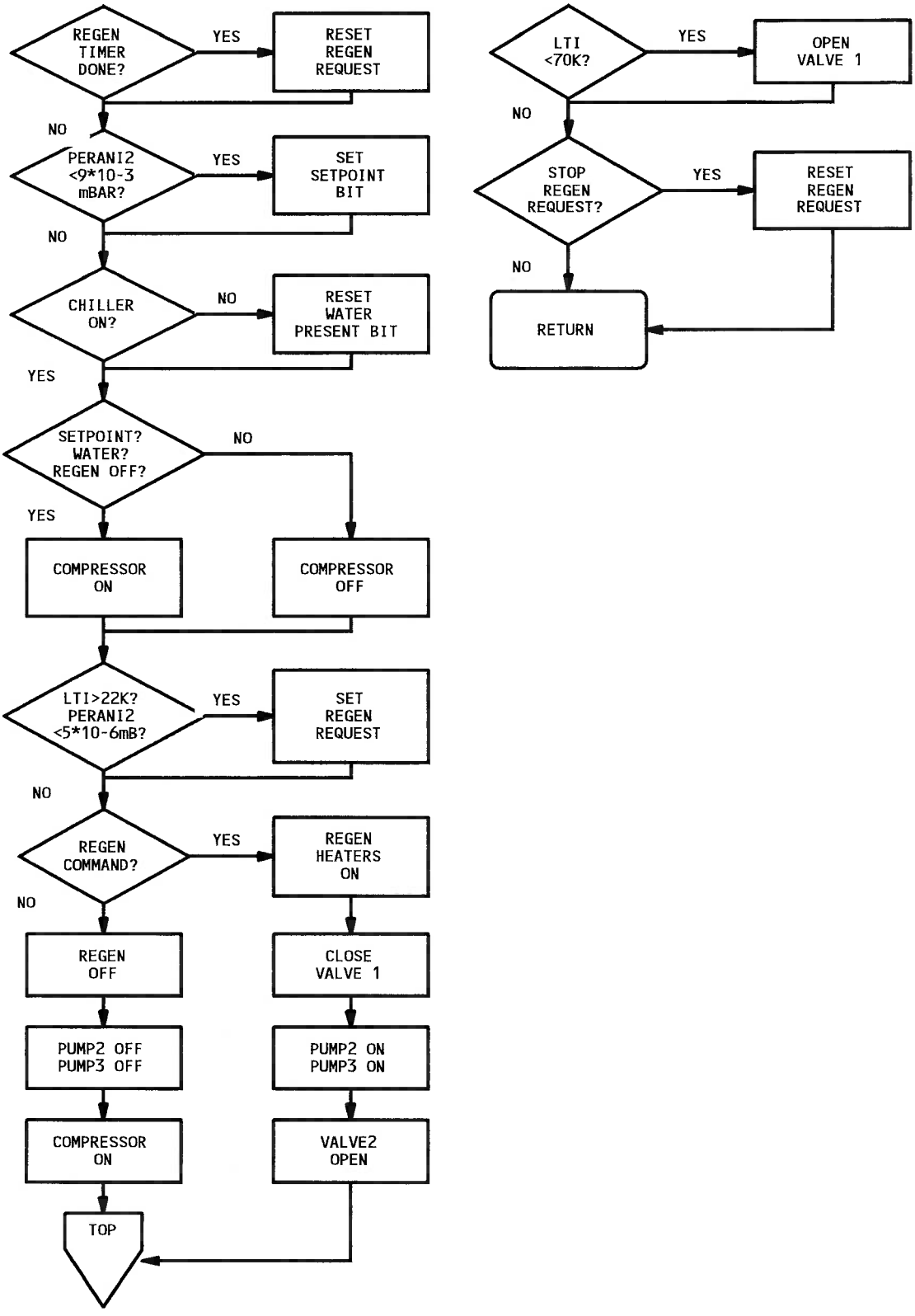
* Stop Compressor and Close Valve 1 will only appear if the compressor is running and valve 1 is open.

2.3 REGENERATION OF CRYOPUMP

When the cryopump becomes saturated during a test cycle, the cryopump can be isolated from the test chamber in order to be regenerated. This signs of saturation are observed by a rise in the cold head temperature. If the cold head temperature > 20^{o} K, the He compressor is functioning normally and the pressure inside the test chamber rises steeply, one can assume that the cryopump (cold head) is saturated.

2.3.1 General Description of Regeneration Sequence.

The regeneration sequence is described in Flow diagram 2 "Regeneration of Cryopumps; Logic Control Diagram".



Flow Diagram 2 - Regeneration of the Cryopump Logic Flow Chart

2.3.2 Operators Instruction

Follow the regeneration steps as described in paragraph 7.7.3 of this section "Operators Dialogue".

3 THERMAL SYSTEM

3.1 PURGE SYSTEM

3.1.1 General Description

This cycle is used to purge the thermal system of any impurities (e.g. moisture) with nitrogen gas prior to start up. The purging cycle must be initiated in the following circumstances:

- If the system has not been in use for an extended period
- After any maintenance has been carried out, especially if such maintenance involved opening of the thermal system.
- Any chance of getting air/moisture into the system.

Warning : Moisture in the system can cause ice blockages when the system is operating at sub zero temperatures.

The purge cycle consists of three separate sub cycles. Each of these sub cycles purge a different part of the thermal system. The purge cycle starts with an initial status set up for certain components and valves. This is as follows:

COMPONENT		
NO	DESCRIPTION	STATUS
RF 100	Fan	Off
HU 100	Heater	Off
V 106	Cooler Valve	Closed
V 109	Flooding Valve	Closed
V 112	Exhaust/Pressure Control Valve	Closed
V 126 & V123	Purge Valve	Closed
V 101 - V 102	Shroud Balance Valves	Open (Pre-set)
V 103	Drain Valve	Closed
V 135	Flashing Chamber Valve	Closed
V 128	Pressure Relieve Valve (hand)	Closed
V 129	Fan Purge Valve	Closed

5 bar

First sub cycle:

The first sub cycle purges the shrouds, the flashing chamber and all pipework between the thermal generator and shrouds. This involves opening valves V135 (manually), V123 and V126 for 3 minutes. After 3 minutes close V123 and V126 first and then close V135 manually.

Second sub cycle:

The second sub cycle allows purging of the injection unit, heater unit and gas circulation fan. This is done by opening of valves V 101, V 102 (manually) and open valve V112, V123 and V126. The second sub cycle lasts one minute after which valve V12 close. The system pressure is then allowed to build up to the required set point whereafter valves V123 and V126 are closed. Valves V101 and V102 have to manually reset to original "balance" position.

Third sub cycle:

The ~~fourth~~ third sub cycle allows purging of the fan motor compartment, and is done manually by opening of valve V 129 for one minute. The system is now ready for operation.

Note: **All above sub-cycles are "manually" initiated (electric valve) from the Main Control Panel) (MCP-2).**

3.1.2 Detailed Instructions

In order to open valves V123 and V126 the following actions should be performed.

1. From the main menu select F7 'THERMAL CONTROL MENUS' (Refer Figure 1, section 7).
2. From the Thermal System Manual Control 1 menu that appears, (Refer Figure 4, section 7) press F9 'NEXT SCREEN'.
3. From the Thermal System Manual Control 2 menu (Refer Figure 5, section 7) select F3 - 'Open Valve 123' and F4 'Open Valve 126'.
4. Remain at this menu until the system has been purged.
5. Once the system has purged select F3 'SHUT VALVE 123' and F4 'SHUT VALVE 126'.
6. Press F10 to return to the main menu.

3.2 THERMAL CYCLE(S)

WARNING: COMPLETE PURGE CYCLE BEFORE PROCEEDING WITH THERMAL CYCLE(S)

3.2.1 General Description

The thermal system has two basic modes of operation as follows:

Gaseous mode ("Controlled")

Gaseous nitrogen at 7 bar (absolute) is circulated through the shrouds by the gas circulation fan and can be heated or cooled in the heater and injection (cooler) units respectively. The cooler and heater units are controlled by comparing a set point temperature with the average temperature of gas entering the shrouds. The rear and cylindrical shrouds are factory balanced with "welded-in" choke valves. This sub-assembly and the door shroud are balanced with

manual valves V101 and V102 mounted in the feedback pipes from the shrouds. The shroud temperature in this mode is controlled from 393 °K to 123 °K with a transient rate of 1.5 °K/minute average. It is also possible to hold the shrouds at a constant temperature at any point within the range 393 K to 123 K for any length of time ("Soaking Period"). Thus it is possible to program the system to follow a predetermined profile which may include any number of transients and soaking periods. Paragraph 3.2.2 describes the basic program/sequence steps. Paragraph 3.2.3 gives the detailed operators instructions for running the system in the automatic mode.

Liquid (flooded) mode ("Uncontrolled")

Liquid nitrogen is gravity fed into the shrouds from the flashing chamber. The flashing chamber is in turn fed with liquid nitrogen via valve V 109. The flashing chamber is allowed to fill and gravity feed liquid nitrogen to the shrouds until the shrouds and connecting pipes are completely filled with liquid nitrogen. During this mode valve V 135 is opened to vent gaseous nitrogen from the flashing chamber . In the shrouds and connecting pipes, the liquid nitrogen is allowed to boil off at atmospheric pressure. A differential pressure sensor facilitates the control of valve V 109 such that the level of liquid nitrogen is maintained in the system. The level has to be about at 1/3 of flashing chamber volume. This operating mode is uncontrolled in both the transient from the gaseous mode to a flooded situation, as well as in the steady state flooded mode. During the flooded mode the shroud temperatures are in the region of 78°K to 88°K. Paragraph 3.2.4 describes the basic program/sequence steps. Paragraph 3.2.5 gives the detail operators instructions for running the system in the liquid mode. Refer flow diagram 3 for a detailed description of the program sequence.

3.2.2 Gaseous Mode Program Steps

The basic steps of the automated program are as follows:

Note: This cycle is always preceded by a purge cycle. This means the thermal system is already on "set" pressure and valve status remains as per end of purge cycle. Pressure control valve V112 is active.

- Open V101 & V102 (shroud balance control valves) to balance the flow rate.
- Depend on pre-programmed thermal profile (mask) the heater or cooler units will become active to heat up or cool down the recirculation gas.

Note:

- **To follow transient profiles (ΔT/min) within acceptable tolerances, both heater and cooler units are used in a push-pull mode during a transient.**
- The system is well interlocked to prevent undesirable scenarios. See paragraph 4 for "Interlock conditions".

Warning: When the cooler unit is functioning, mass (LN_2) is injected into the system. That means mass in the form of gas (GN_2) has to be released to keep mass/pressure balance inside the

pressure boundary of the thermal system. If for instance the exhaust/pressure control valve is stuck in a closed position, and LN_2 is still injected into the system, the pressure will build up and result in blowdown of the safety valves. For this scenario, the cooler injection valve V106 will be interlocked on high pressure signal. (Valve V106 will close).

3.2.3 Gaseous Mode Detail Instruction

Before the thermal system will start, the following must be met:

1. Compressed air on.
2. Chilled water flowing.
3. System pressure > 4 bar (5 bar absolute).
4. Profiles must be present in the thermal setpoint menu. Refer section 7.5 as how to do this.

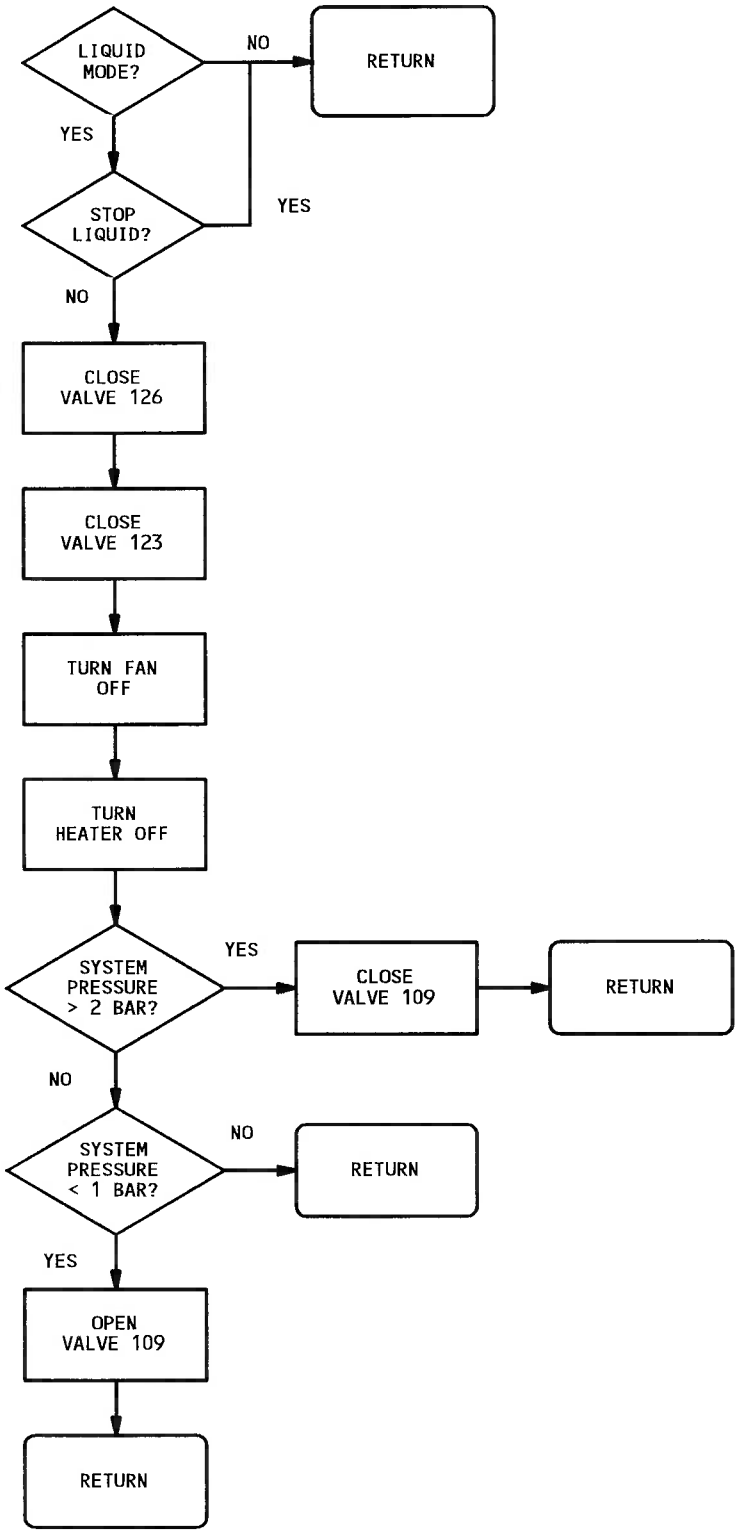
Once the above conditions have been met, and the system is at high vacuum, the thermal system may be started. In order to start the thermal system, select the main menu by pressing the F10 key from any of the sub-menus.

1. Turn the key switch to the 'CONFIDENTIAL MODE'.
2. Press the F3 'START THERMAL SYSTEM' key.
3. Once the message 'STOP THERMAL SYSTEM' appears return the key switch to the 'NORMAL' position.

The thermal system will stop automatically when a given step has a setpoint time of 0 minutes and setpoint value of 0 degrees.

The thermal system may be stopped at any given time by selecting F3 'STOP THERMAL SYSTEM'* from the main menu.

* This message will only be displayed if the thermal system is running.



Flow diagram 3

3.2.4 Liquid Mode - Basic Program/Sequence Steps & Philosophy

The basic steps of the automated program for the liquid mode are as follows:

Note: This cycle is always preceded by a automatic controlled gas mode cycle, ended at an average system temperature of 123^{0} K (-150^{0} C). All valve status as per gas mode operation:

Entry into liquid mode:

1. Switch heater unit (HU100) off. (Automatic)
2. Switch recirculation fan (RF100) off (Automatic)
3. Set system pressure to 0 bar, (1 Bar absolute), in thermal control panel. (Manual)
4. Set flashing chamber level to 0 mm water. (Manual)
5. Keep V101 and V102 in preset position.
6. Open flashing chamber valve V135. (Manual)
7. ~~Open~~ hand valve V107 (Manual)
8. Make sure drain valve V103 is closed. (Automatic)
9. Close purge valves V123 and V126. (Automatic)
10. Close cooler unit spray valve V106 (Automatic)

Note: The system is now ready to be flooded with liquid nitrogen.

11. Control the LN2 injection with flooding valve V109 by slowly increasing the level on the flashing chamber level controller.

Note: The high set point level is reached when the level controller meter indicates 1/3 level inside the flashing chamber, (approximately ~~360~~ 200-250 mm water).

12. The system will remain in the liquid mode until the operator selects the "STOP LIQUID" mode.

Note: The system will only start liquid mode once the system pressure is lower than 1 bar (2 bar absolute)

3.2.5 Liquid Mode: Detail Operators Instruction

In order to engage liquid mode, the operator must enter a setpoint of -160°C or lower in the chamber setpoint update menu, refer section 7,5, as how this may be done.

3.3 DRAIN CYCLE

3.3.1 General Description:

Most of the liquid is drained by gravity through the drain valve and collected in the boil-off vat outside the building. The door shroud will not drain under gravity, but most of the LN_2 can be pushed out of the shroud by purging with GN_2.

3.3.2 Drain Cycle - Basic Program/Sequence Steps and Philosophy

The basic steps of the automated program are as follows:

Note: This cycle is always preceded by a liquid mode cycle. This means that the system is filled with LN_2 and is near to atmospheric pressure at initiation time of the drain cycle

Refer flow diagram 4 for a detailed description of the program sequence.

Warning: Never close (override) exhaust valve V112 during the drain cycle. Even with the drain valve open, a "too high" the system may overpressurise.

Warning: Before termination of the purge cycle to go into a controlled gas mode, PT100C & PT100B must be >-140° C (>~~170°K~~) 133K

3.3.3 Drain Cycle Detail Operators Instruction.

1. Set flashing chamber level controller to 0 mm water. (Manual). *
2. Close inline valve feeding valve V109 (Manual hand valve V107). *
3. Select "STOP LIQUID" on thermal mimic. *
4. Open valves V123 and V126. (Automatic).
5. Close valve V109. (Automatic)
6. Adjust pressure control to 1.2 bar (2.2 Bar absolute) (Manual). * ← Close value V135 *
7. When system pressure reaches 1 bar (2 bar absolute) drain valve V103 will open.
8. System will drain until ~~average temperature~~ B & C > -140 Celcius, then drain valve V103 will close.

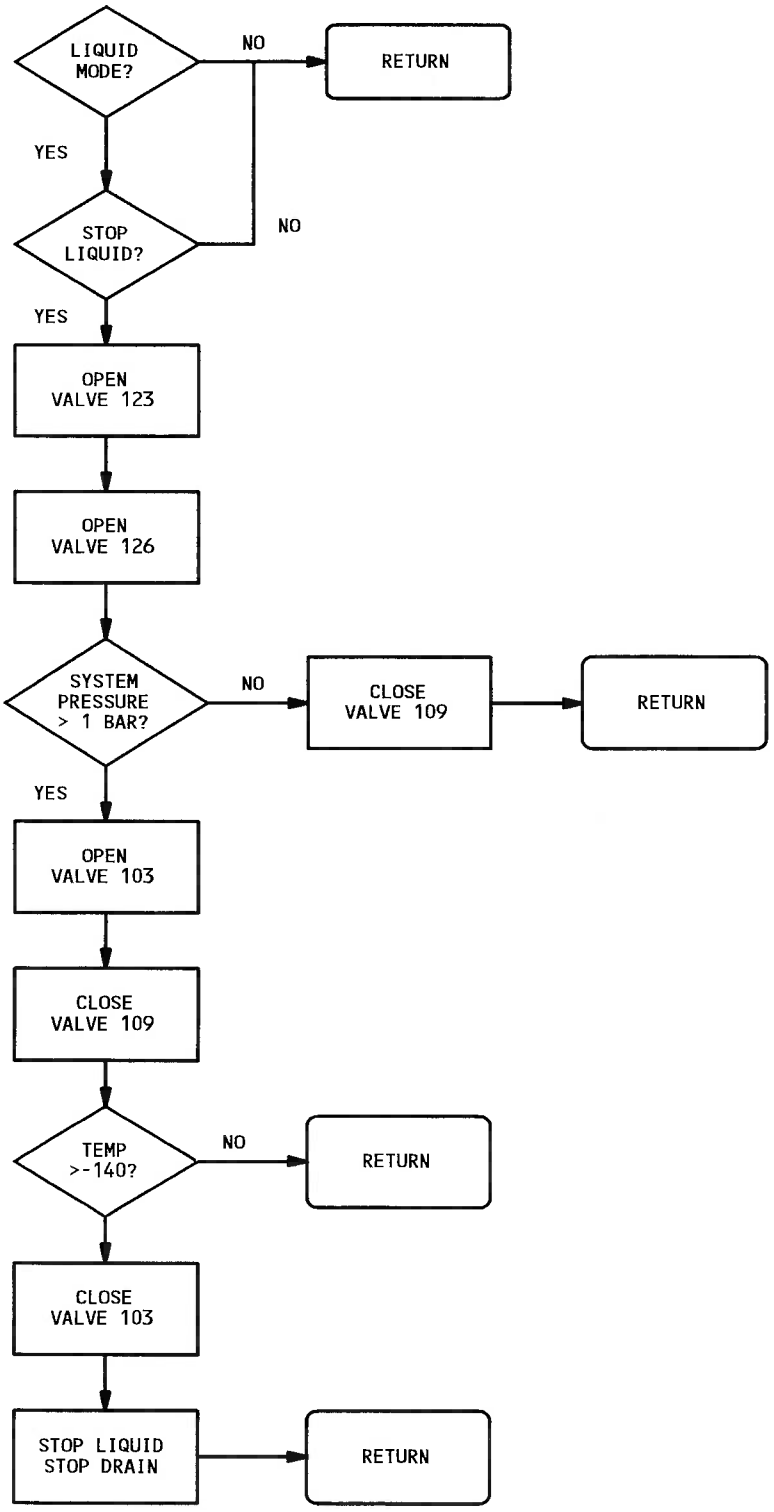
10 8. Liquid mode and Drain mode will ~~no longer~~ be displayed on thermal mimic, UNTIL SYSTEM PRESSURE IS RAISED TO 4,5 BAR OR ABOVE.

/

9. Adjust system pressure to 5.5 bar (6.5 bar absolute).

11. Next profile step may be executed.

Note: The drain valve will only open once the system pressure is higher than 1 bar. (2 Bar absolute).



DRAIN MODE
FLOW DIAGRAM

Flow diagram 4.

3.4 DOWTHERM SYSTEM

3.4.1 Dowtherm Description

The Dowtherm system is an open system comprising of a vessel housing the dowtherm liquid which is may be cooled to -80 degrees centigrade and heated to +80 degrees centigrade 3. The dowtherm vessel is connected to the test plate and dowtherm liquid is circulated through the test plate by a pump.

Cooling of the dowtherm liquid is achieved by circulating a proportionally controlled amount of liquid nitrogen through the dowtherm, and heating is achieved by an open heating element which is powered by a proportionally controlled thyristor drive. An agitator is used to agitate the dowtherm liquid to ensure even temperature distribution throughout the dowtherm vessel. In the event that the outlet pipe fom the dowtherm vessel blocks, an over-pressure sensor fitted to the vessel will switch off the pump.

3.4.2 Dowtherm System Detailed Instructions

Before starting the dowtherm system, ensure that hand valves V116, V119 and V120 are open. Enter the required setpoints for the dowtherm system as described in section 7.4. From the main menu select F4 "Start Dowtherm System". The PLC will automatically start the dowtherm pump and agitator, and open the nitrogen solenolid (Valve 115 cut off). When the dowtherm system is running, the message "Stop Dowtherm System" will appear next to the F4 selection column on the main menu. The two methods may be used to stop the dowtherm system :

(1) **Automatic**

The dowtherm system will execute the profile values entered in the dowtherm setpoint menu until the time period and setpoint values are both zero.

(2) **Manual**

Pressing the F4 key on the main menu when the message "Stop Dowtherm System" is displayed.

When the dowtherm stops, both the heater and the cooler are de-activated, the dowtherm pump and agitator remain on. In order to turn the pump and agitator off, the operator must follow the sequence described below:

(1) From the main menu, select F7 "Thermal Control Menus".

(2) From the Thermal System Manual Control 1 menu select F1 "Stop Dowthermal Pump"*.

(3) Select F2 "Stop Dowthermal Stirrer"*.

* These messages will only be displayed if the components in question are running.

3.4.3 Purging the Dowtherm System

Purging of the dowtherm system is achieved by forcing gaseous nitrogen into the dowtherm pipes connecting the dowtherm vessel to the test plate. Before purging the dowtherm system, ensure that hand valves V119 and V120 are closed. From the Thermal System Manual Control 1 menu select F3 "Purge Dowtherm System". The system will now purge. When dowtherm can no longer be observed flowing into the dowtherm vessel, the system has been purged. From the Thermal System Manual Control 1 menu select F3 to stop the dowtherm purge sequence.

3.4.4 Draining the Dowtherm Vessel

Before draining the dowtherm system, first purge the system as described above. Once the purge sequence has been completed, open hand valve V118 to drain the system

4 INTERLOCK CONDITIONS FOR MEDIUM THERMOVACUUM FACILITY IN AUTOMATIC OPERATING MODE.

Interlock conditions for medium thermovacuum facility.

Component	Interlock	Action
Thermal heater:	System pressure < 4 Bar. Gas temperature > 140 degrees. Liquid Mode. Fan off.	Thermal heater off.
Thermal cooler:	Liquid mode.	Thermal cooler off.
Dowthermal heater:	Agitator off. Temperature > 115 Celcius.	Dowtherm heater off.
Thermal fan:	No flow at flow switch. Fan temperature > 60 Celcius.	Fan off.
Dowthermal system:	Chilled water off. Compressed air off.	System will reset.
Thermal system:	Chilled water off. Compressed air off.	System will reset.
Vacuum system:	Chilled water off. Compressed air off	System will reset.

5 ALARMS FOR GASEOUS AND LIQUID MODES

ALARMS	ACTION	MODE
CHILL WATER FAIL	THERMAL SYSTEM OFF	AUTOMATIC
	VACUUM SYSTEM OFF	AUTOMATIC
	DOWTHERM SYSTEM OFF	AUTOMATIC
COMPRESSED AIR FAILURE	THERMAL SYSTEM OFF	AUTOMATIC
	VACUUM SYSTEM OFF	AUTOMATIC
	DOWTHERM SYSTEM OFF	AUTOMATIC
PT100 FAILURE	NOTIFICATION ON MIMIC	AUTO & MANUAL
VIII OPEN & NO FLOW	ALARM	AUTO & MANUAL
VIII FAILURE	ALARM	AUTO & MANUAL
COMPRESSOR FAILURE	ALARM	AUTO & MANUAL
PUMP 2 FAILURE	ALARM	AUTO & MANUAL
PUMP 3 FAILURE	ALARM	AUTO & MANUAL
V123 FAILURE	ALARM	AUTO & MANUAL
V103 FAILURE	ALARM	AUTO & MANUAL
V112 FAILURE	ALARM	AUTO & MANUAL
V126 FAILURE	ALARM	AUTO & MANUAL
V1 FAILURE	ALARM	AUTO & MANUAL
V3 FAILURE	ALARM	AUTO & MANUAL
PERANI 1 FAILURE	INDICATION ON MIMIC	AUTO & MANUAL
PERANI 2 FAILURE	INDICATION ON MIMIC	AUTO & MANUAL
PENNING FAILURE	INDICATION ON MIMIC	AUTO & MANUAL

6 MANUAL MODE OPERATION.

Sections 7.2, 7.3 and 7.6 describe the functions that may be performed in manual mode.

7. OPERATORS DIALOGUE

7.1. MAIN MENU DESCRIPTION.

Refer Figure 1.

The following are controlled directly from this menu:

F01 Panic Abort. This will reset the PLC and all setpoint data previously stored will be lost.
F02 Start / Stop Vacuum system.
F03 Start / Stop Thermal system if setpoint data has been entered.
F04 Start / Stop Dowtherm system if setpoint data has been entered.
F05 Manual / Automatic modes. This mode affects the PID operation only. The heaters and coolers are controlled manually, system operation is not otherwise affected.

The following sub-menus may be activated from the main menu:

F06. Manual control menus for the vacuum system.
F07. Manual control menus for the thermal system.
F08. Dowtherm setpoint menu.
F09. Thermal setpoint menu.
F10. PID control menu.
F11. Vacuum mimic.
F12. Thermal mimic.

MEDIUM VACUUM SYSTEM
MAIN MENU OPTIONS

F 1 - PANIC ABORT
F 2 - START VACUUM SYSTEM
F 3 - START THERMAL SYSTEM
F 4 - START DOWTHERM SYSTEM
F 5 - ENGAGE MANUAL MODE
F 6 - VACUUM CONTROL MENUS
F 7 - THERMAL CONTROL MENUS
F 8 - DOWTHERM SETPIONT MENUS
F 9 - CHAMBER SETPOINT MENU
F10 - THERMAL PID MENU
F11 - VACUUM SYSTEM MIMIC
F12 - THERMAL SYSTEM MIMIC

NOTE: RED - CONFIDENTIAL MODE ONLY.

FIGURE 1

7.2. MANUAL VACUUM SYSTEM CONTROL MENUS.

The following devices may be activated from the manual vacuum control menu 1:

F01 Start/Stop compressor
F02 Start/Stop pump 2
F03 Start/Stop pump 3
F04 Turn Sorption trap on/off
F05 Turn spare contactor on/off

The following menus may be activated from the manual vacuum control menu 1, refer Figure 2.

F09. Manual vacuum control menu 2.
F10. Main menu

The following valves may be activated from the manual vacuum control menu 2:

F01 Open/Close valve 1
F02 Open/Close valve 2
F03 Open/Close valve 3
F04 Open/Close valve 5

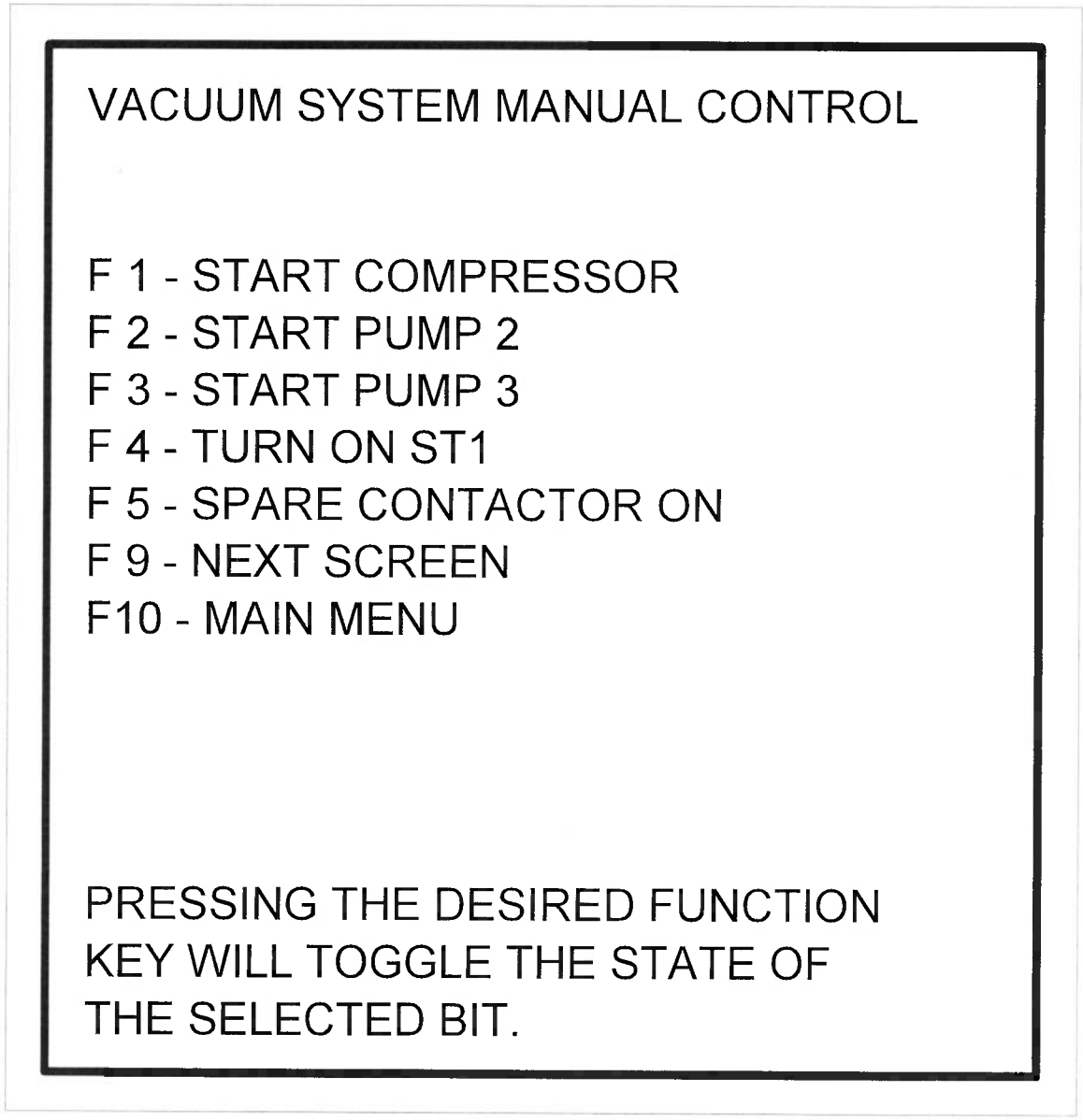


FIGURE 2

The following menus may be activated from the manual vacuum control menu 2, refer Figure 3.

F09. Manual vacuum control menu 1.
F10. Main menu

NOTE: **When the vacuum system is running, the PLC will automatically over-ride any selection made by the operator. The control is passed to the operator when the vacuum system is switched off.**

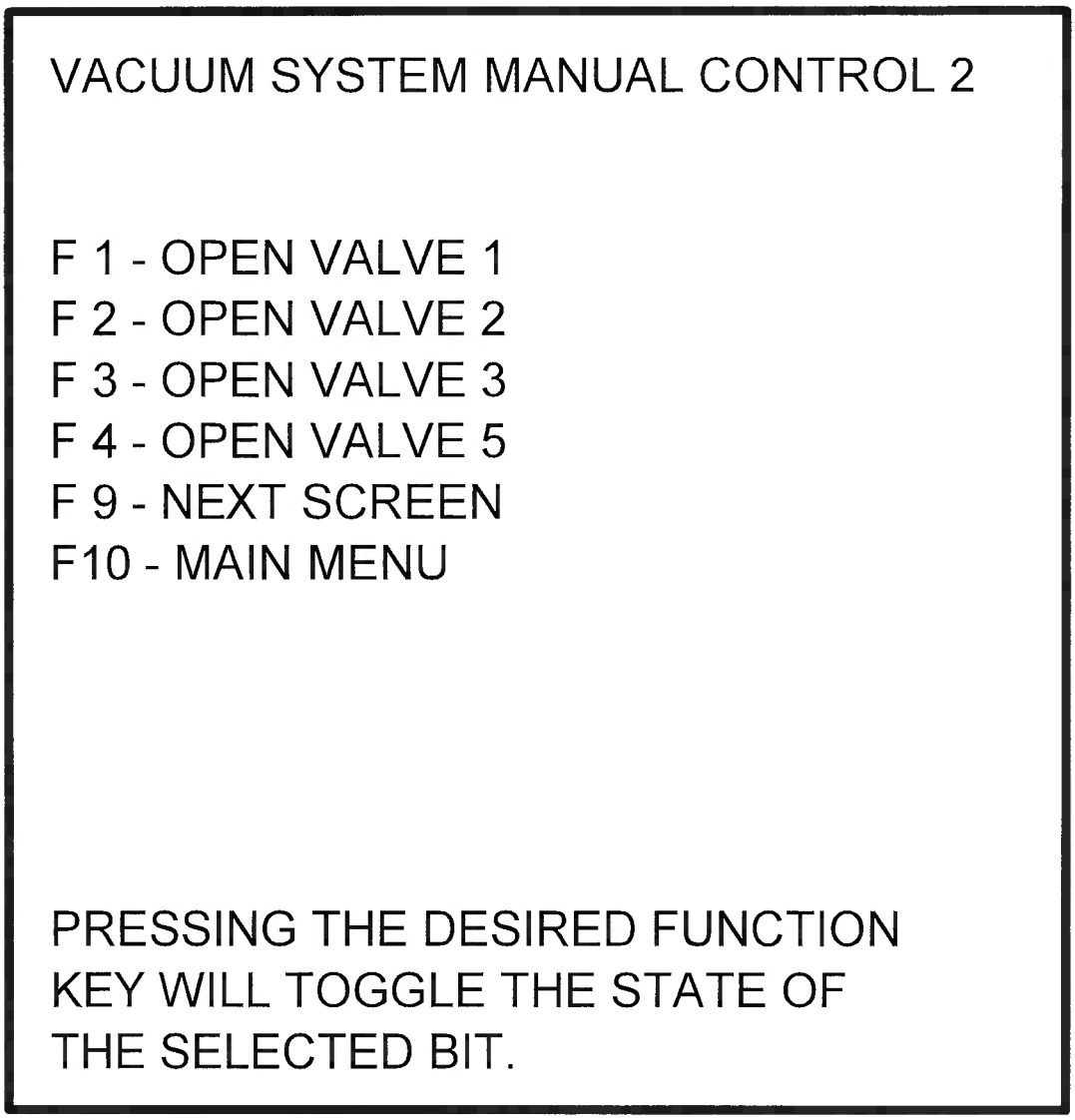

VACUUM SYSTEM MANUAL CONTROL 2
F 1 - OPEN VALVE 1
F 2 - OPEN VALVE 2
F 3 - OPEN VALVE 3
F 4 - OPEN VALVE 5
F 9 - NEXT SCREEN
F10 - MAIN MENU
PRESSING THE DESIRED FUNCTION KEY WILL TOGGLE THE STATE OF THE SELECTED BIT.

FIGURE 3

7.3. MANUAL THERMAL SYSTEM CONTROL MENUS.

The following devices may be activated from the manual thermal control menu 1:

F01 Start/Stop Dowtherm pump
F02 Start/Stop stirrer
F03 Start/Stop Dowtherm purge
F04 Open/Close Nitrogen solenoid for Dowtherm cooler.

The following menus may be activated from the manual thermal control menu 1, refer Figure 4.

F09. Manual thermal control menu 2.
F10. Main menu

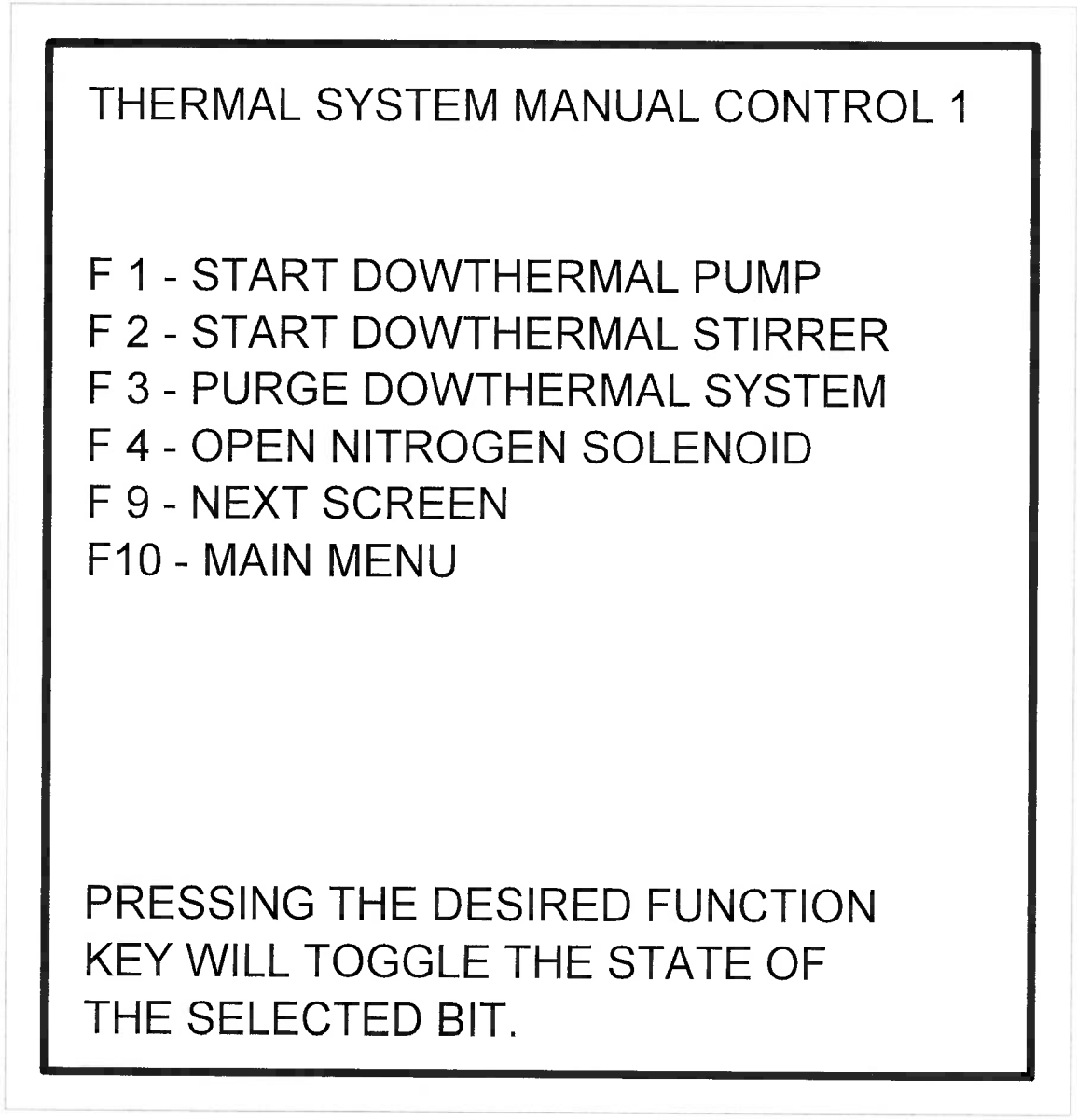


FIGURE 4

The following valves may be activated from the manual thermal control menu 2:

F01 Open/Close valve 103
F02 Open/Close valve 111
F03 Open/Close valve 123
F04 Open/Close valve 126

The following menus may be activated from the manual thermal control menu 2, refer Figure 5.

F09. Manual thermal control menu 1.
F10. Main menu

NOTE: **When the thermal system is running, the PLC will automatically over-ride any selection made by the operator. The control is passed to the operator when the thermal system is switched off.**

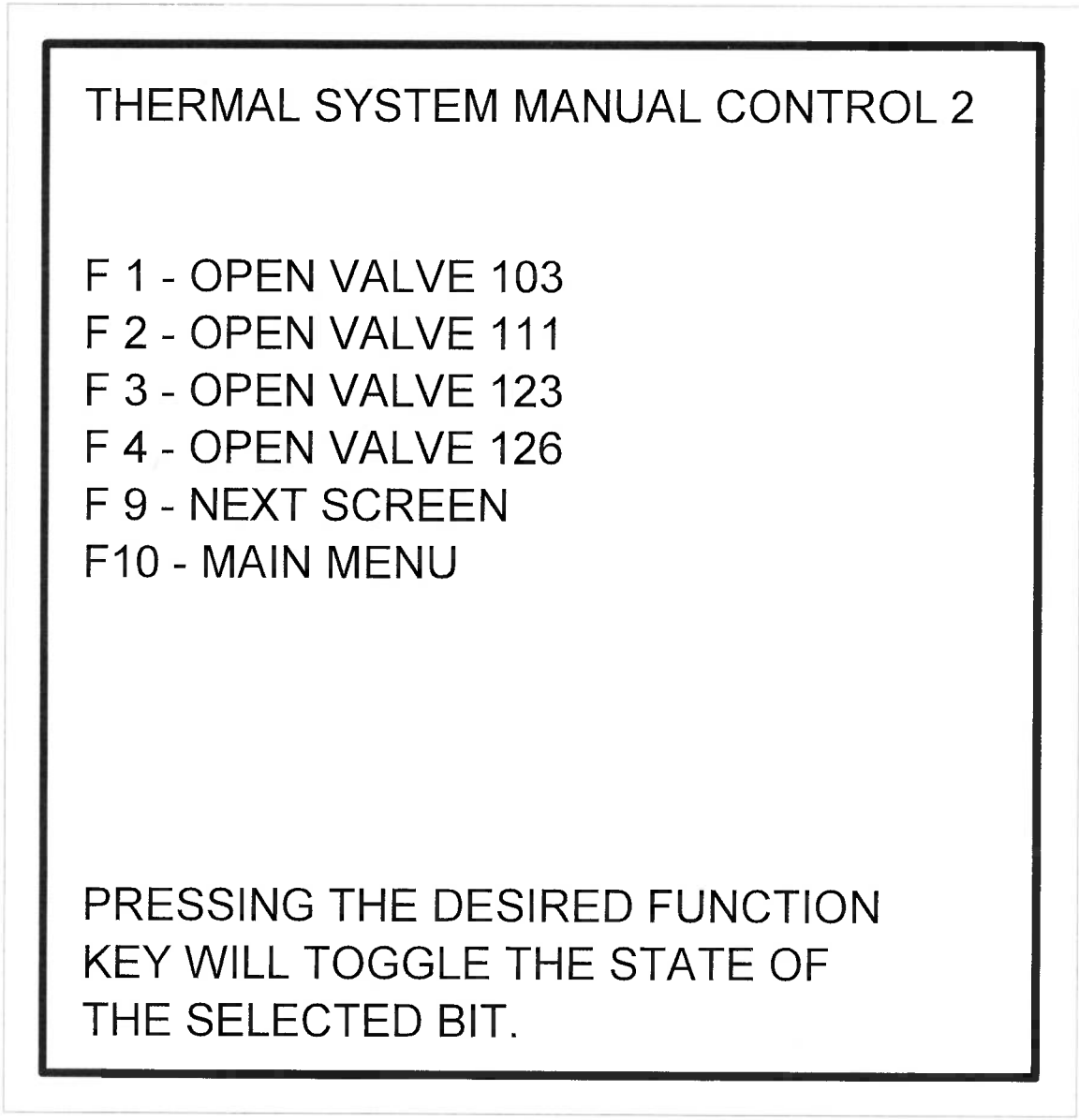


FIGURE 5

7.4. DOWTHERM SETPOINT MENU.

Refer Figure 6.

This menu is used to input setpoint data into the PLC for use by the Dowtherm system. The data is displayed in three columns representing:

DOWTHERMAL UPDATE MENU

CURRENT STATUS	DEFAULT VALUE	UPDATED VALUE	OSS KEY	COMMENT
MINUTES	MINUTES	MINUTES	F 1	TIME IN MINUTES
DEGREES	DEGREES	DEGREES	F 2	SETPOINT IN deg/C
NUMBER	NUMBER	NUMBER	F 3	STAGE NO 0-99

F 1 TO ALTER STEADY STATE TIME
F 2 TO ALTER TEMPERATURE VALUE
F 3 TO SELECT NEW STATE NUMBER
F 4 TO WRITE DATA INTI PLC
F 5 TO INSERT DATA INTO TABLE
F10 MAIN MENU

FIGURE 6

7.4.1 Current Status Minutes

If the Dowtherm system is running, the steady state time for the active stage is displayed in the Minutes column. If the Dowtherm system has reached the required steady state setpoint, the time remaining is displayed in this column.

7.4.2 Current Status Degrees

This column displays the current setpoint of the Dowthermal system if it is running.

7.4.3 Current Status Number

This column displays the current stage number being executed. Data may only be inserted after the number displayed in this column if it is to be executed in the current profile mask.

7.4.4 Default Value Minutes

This column displays the default time for a selected stage number. If the operator wishes to view the data, the following sequence should be followed:

7.4.4.1 Press F3

7.4.4.2 Enter the required stage number in the Updated Value Number column.

7.4.4.3 The default time will now appear in the Default Value Minutes column.

7.4.4.4 If the time displayed is zero, then no data had previously been entered.

7.4.5 Default Value Degrees

This column displays the default setpoint for a selected stage number. If the operator wishes to view the data, the following sequence should be followed:

7.4.5.1 Press F3

7.4.5.2 Enter the required stage number in the Updated Value Number column.

7.4.5.3 The default temperature will now appear in the Default Value Degrees column.

7.4.5.4 If the temperature displayed is zero, then no data had previously been entered.

7.4.6 Default Value Number

This column indicates the stage number pertinent to the data being displayed.

7.4.7 Updated Value Minutes

This is the steady stage time entry column. In order to enter a value, the following sequence should be followed:

7.4.7.1 Press the F1 key. The minutes column should be highlighted.

7.4.7.2 Enter the time in minutes

7.4.7.3 Press Enter.

7.4.8 Updated Value Degrees

This is the steady stage setpoint entry column. In order to enter a value, the following sequence should be followed:

7.4.8.1 Press the F2 key. The degrees column should be highlighted.

7.4.8.2 Enter the setpoint in degrees centigrade.

7.4.8.3 Press Enter.

7.4.9 Updated Value Number

This is the column where a steady stage number may be selected. In order to select a stage number, the following sequence should be followed:

7.4.9.1 Press the F3 key. The number column should be highlighted.

7.4.9.2 Enter the required stage number.

7.4.9.3 Press enter.

DOWTHERMAL UPDATE MENU

CURRENT STATUS	DEFAULT VALUE	UPDATED VALUE	OSS KEY	COMMENT
MINUTES	MINUTES	MINUTES	F 1	TIME IN MINUTES
DEGREES	DEGREES	DEGREES	F 2	SETPOINT IN deg/C
NUMBER	NUMBER	NUMBER	F 3	STAGE NO 0-99

F 1 TO ALTER STEADY STATE TIME
F 2 TO ALTER TEMPERATURE VALUE
F 3 TO SELECT NEW STATE NUMBER
F 4 TO WRITE DATA INTI PLC
F 5 TO INSERT DATA INTO TABLE
F10 MAIN MENU

FIGURE 6

7.4.10 Function Key Description.

F1 Used to enter the steady state time values.
F2 Used to enter the steady state temperature values.
F3 Used to select a stage number.
F4 Used to write the data into the PLC after the data has been entered.
F5 Used to insert a step. Note that the step number inserted should be greater than the value displayed in the Current Status Number column. Inserting a step number smaller than the value displayed in this column will not be valid during the current profile.
F10 Return to the main menu.

7.5. THERMAL SETPOINT MENU.

Refer Figure 7.

This menu is used to input setpoint data into the PLC for use by the thermal system. The data is displayed in three columns representing:

CHAMBER SETPOINT UPDATE MENU

CURRENT STATUS	DEFAULT VALUE	UPDATED VALUE	OSS KEY	COMMENT
MINUTES	MINUTES	MINUTES	F 1	TIME IN MINUTES
DEGREES	DEGREES	DEGREES	F 2	SETPOINT IN deg/C
NUMBER	NUMBER	NUMBER	F 3	STAGE NO 0-99

F 1 TO ALTER STEADY STATE TIME
F 2 TO ALTER TEMPERATURE VALUE
F 3 TO SELECT NEW STATE NUMBER
F 4 TO WRITE DATA INTI PLC
F 5 TO INSERT DATA INTO TABLE
F10 MAIN MENU

FIGURE 7

7.5.1 Current Status Minutes

If the thermal system is running, the steady state time for the active stage is displayed in the Minutes column. If the thermal system has reached the required steady state setpoint, the time remaining is displayed in this column

.

7.5.2 Current Status Degrees

This column displays the current setpoint if the thermal system is running.

7.5.3 Current Status Number

This column displays the current stage number being executed. Data may only be inserted after the number displayed in this column if it is to be executed in the current profile mask.

7.5.4 Default Value Minutes

This column displays the default time for a selected stage number. If the operator wishes to view the data, the following sequence should be followed:

7.5.4.1 Press F3

7.5.4.2 Enter the required stage number in the Updated Value Number column.

7.5.4.3 The default time will now appear in the Default Value Minutes column.

7.5.4.4 If the time displayed is zero, then no data had previously been entered.

7.5.5 Default Value Degrees

his column displays the default setpoint for a selected stage number. If the operator wishes to view the data, the following sequence should be followed:

7.5.5.1 Press F3

7.5.5.2 Enter the required stage number in the Updated Value Number column.

7.5.5.3 The default temperature will now appear in the Default Value Degrees column.

7.5.5.4 If the temperature displayed is zero, then no data had previously been entered.

7.5.6 Default Value Number

This column indicates the stage number pertinent to the data being displayed.

7.5.7 Updated Value Minutes

This is the steady stage time entry column. In order to enter a value, the following sequence should be followed:

7.5.7.1 Press the F1 key. The minutes column should be highlighted.

7.5.7.2 Enter the time in minutes

7.5.7.3 Press Enter.

7.5.8 Updated Value Degrees

This is the steady stage setpoint entry column. In order to enter a value, the following sequence should be followed:

7.5.8.1 Press the F2 key. The degrees column should be highlighted.

7.5.8.2 Enter the setpoint in degrees centigrade.

7.5.8.3 Press Enter.

7.5.9 Updated Value Number

This is the column where a steady stage number may be selected. In order to select a stage number, the following sequence should be followed:

7.5.9.1 Press the F3 key. The number column should be highlighted.

7.5.9.2 Enter the required stage number.

7.5.9.3 Press enter.

7.5.10 Function Key Description.

F1 Used to enter the steady state time values.
F2 Used to enter the steady state temperature values.
F3 Used to select a stage number.
F4 Used to write the data into the PLC after the data has been entered.
F5 Used to insert a step. Note that the step number inserted should be greater than the value displayed in the Current Status Number column. Inserting a step number smaller than the value displayed in this column will not be valid during the current profile.

F10 Return to the main menu.

CHAMBER SETPOINT UPDATE MENU

CURRENT STATUS	DEFAULT VALUE	UPDATED VALUE	OSS KEY	COMMENT
MINUTES	MINUTES	MINUTES	F 1	TIME IN MINUTES
DEGREES	DEGREES	DEGREES	F 2	SETPOINT IN deg/C
NUMBER	NUMBER	NUMBER	F 3	STAGE NO 0-99

F 1 TO ALTER STEADY STATE TIME
F 2 TO ALTER TEMPERATURE VALUE
F 3 TO SELECT NEW STATE NUMBER
F 4 TO WRITE DATA INTI PLC
F 5 TO INSERT DATA INTO TABLE
F10 MAIN MENU

FIGURE 7

7.6. PID CONTROL MENU.

Refer Figure 8.

7.6.1 Purpose:

The purpose of the PID control menus is to allow the operator to test the proportionally controlled devices installed in the system. These menus may only be controlled if the system is in Manual mode, however, the values output to the devices may be viewed in either the automatic or in the manual modes.

The thermal system heater and the thermal system cooler may be controlled from the PID 1 control menu:

Press F1 to increment the output to the heater.
Press F2 to decrement the output to the heater.
Press F3 to increment the output to the cooler.
Press F4 to decrement the output to the cooler.
The value output will be displayed in percentage below the relevant bar graph.

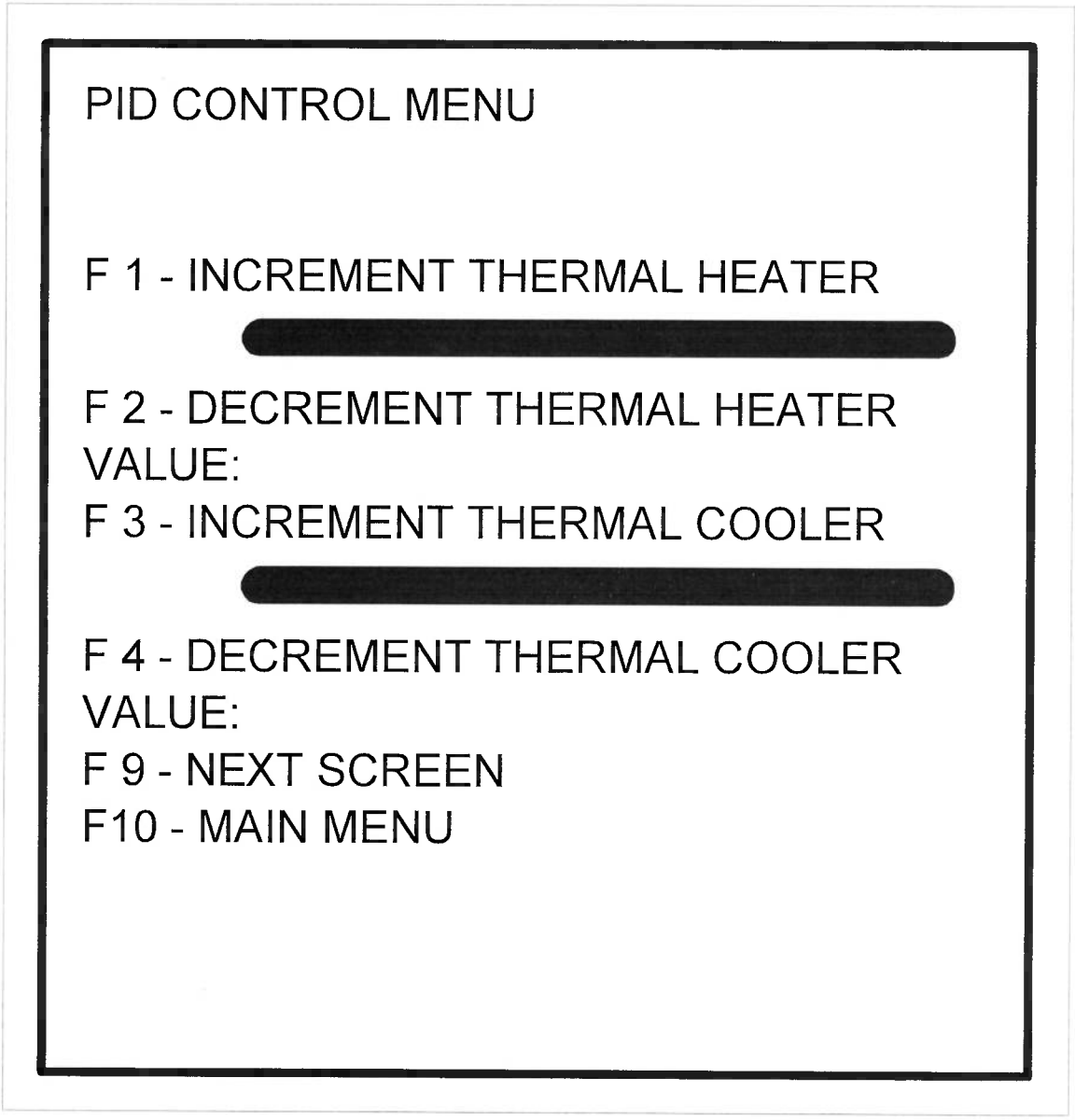


FIGURE 8

The following menus may be activated from the PID 1 control menu refer Figure 8.

F09. PID 2 control menu.
F10. Main menu

The Dowthermal system heater and the Dowthermal system cooler may be controlled from the PID 1 control menu:

Press F1 to increment the output to the Dowthermal heater.
Press F2 to decrement the output to the Dowthermal heater.
Press F3 to increment the output to the Dowthermal cooler.
Press F4 to decrement the output to the Dowthermal cooler.
The value output will be displayed in percentage below the relevant bar graph.

The following menus may be activated from the PID 2 control menu refer Figure 9.

F09. PID 1 control menu.
F10. Main menu

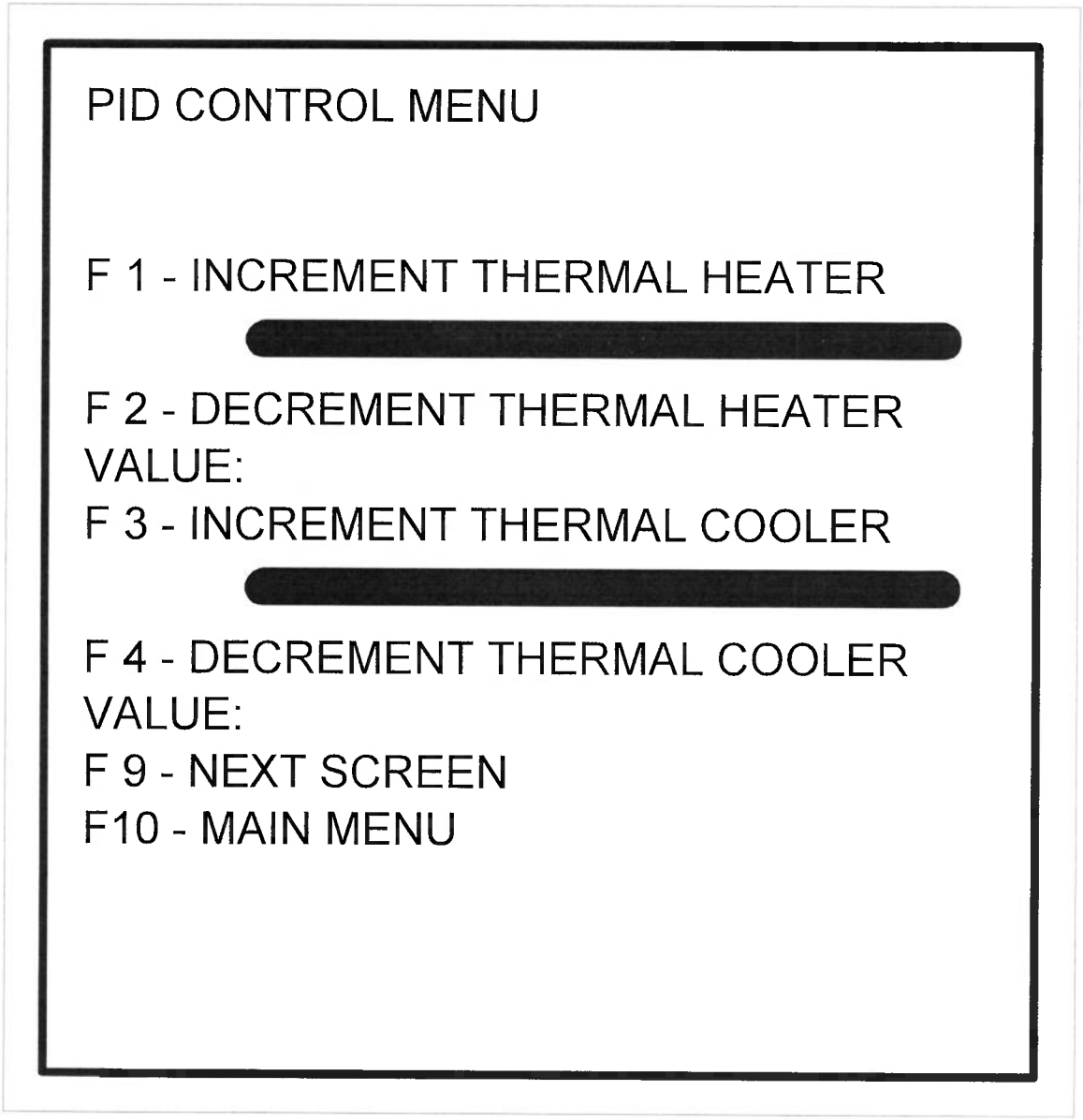


FIGURE 9

7.7. VACUUM MIMIC.

7.7.1 Refer Figure 10.

The vacuum system mimic will indicate the current status of the valves and the pumps used in the vacuum system. To obtain more information on the vacuum status and the cryopump temperatures, the operator must press the F8 and F9 keys respectively, as indicated by the mimic. Pressing the F10 key will return the operator to the main menu.

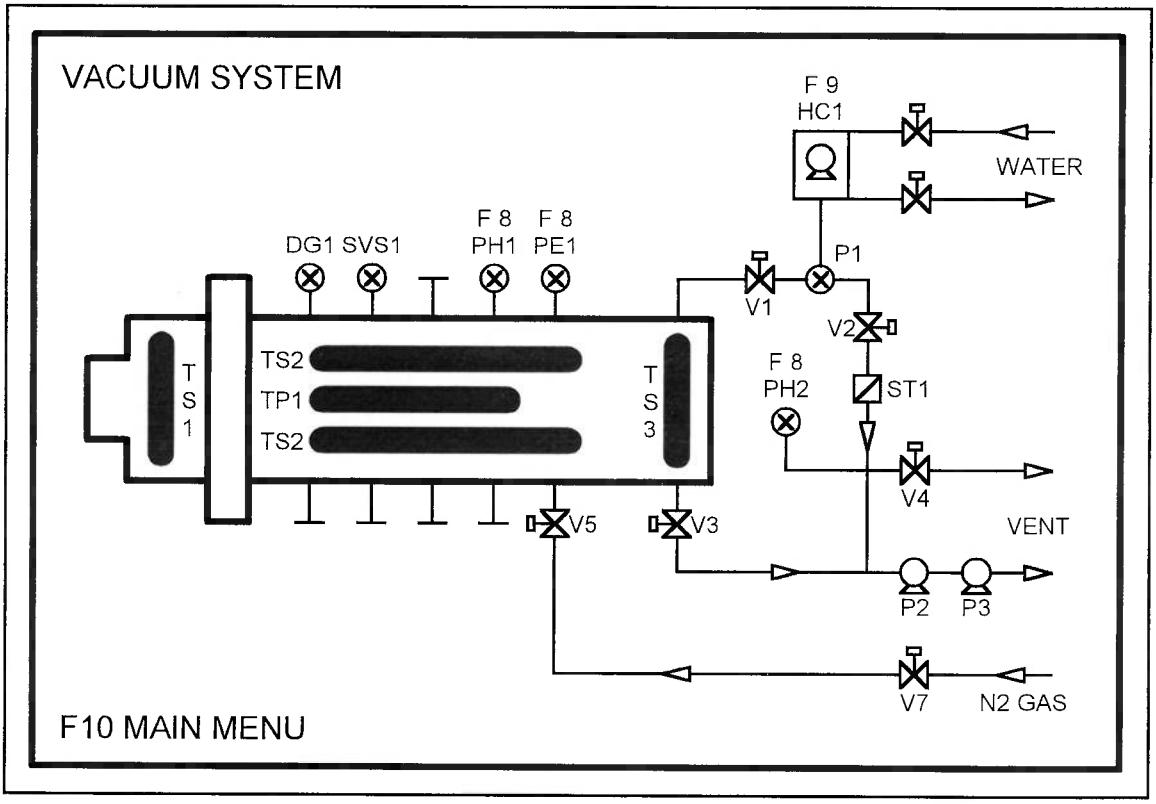


FIGURE 10

7.7.2 F08. Combitron menu. Refer Figure 11.

The Combitron menu displays the status of the two Perani heads and the Penning head. If one of the measuring heads fails, a fail message will appear opposite the head in question. It is strongly recommended that the Penning head be cleaned before each high vacuum cycle, failure to do so may result in a failure during a cycle. Pressing the F08 key will return the operator to the vacuum mimic. Pressing the F10 key will return the operator to the main menu.

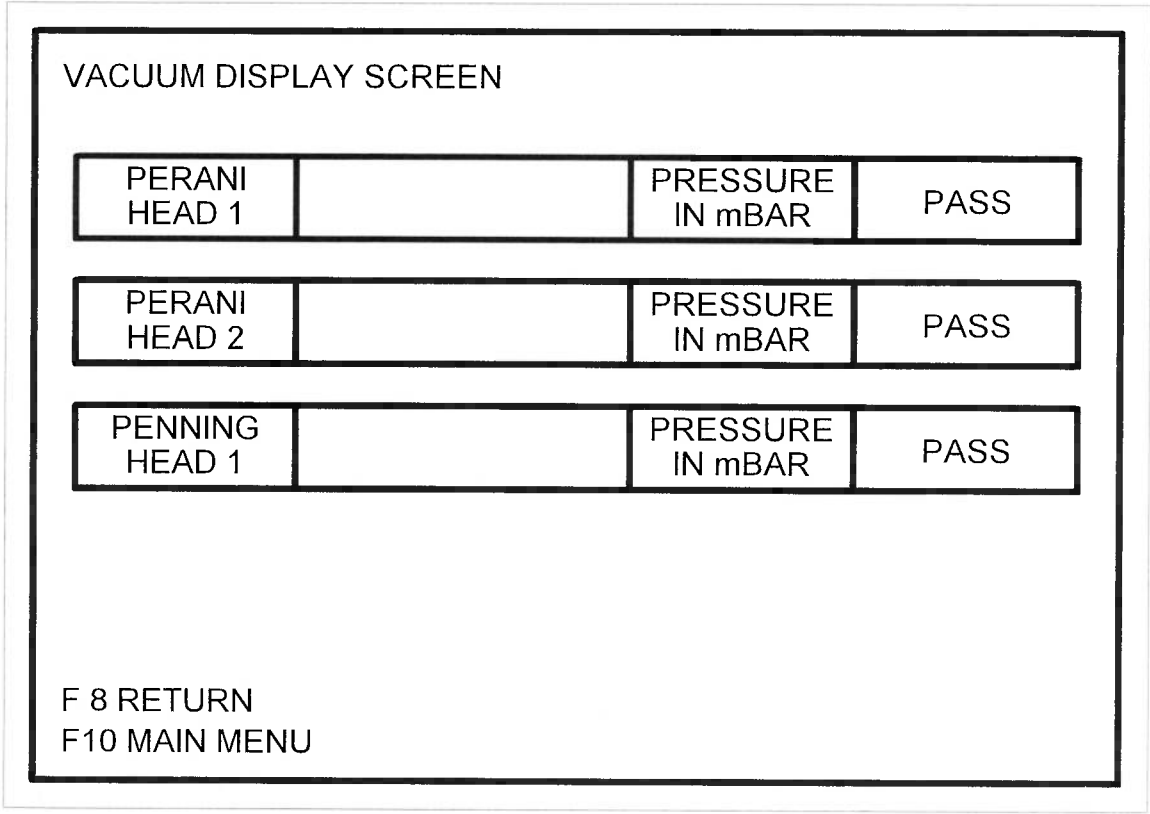


FIGURE 11

7.7.3 F09. Cryopump menu. Refer Figure 12.

The cryopump menu displays the status and the temperature on the cold head of the cryopump. If the sensor diode fails, "FAIL" will flash in the Kelvin area in the cryopump temperature box. If a key is depressed on the low temperature instrument, "KYBD" will flash in the same area.

If the fan cooling water is flowing, "FLOW" will be displayed in the water status box. If the water does not flow, "FAIL" will flash in the same area, the fan and the cryopump compressor will not start

.

When the compressor is running, "RUN" will be displayed in compressor area. If the compressor is not running or the cold head is being regenerated, "STOP" will be displayed.

When the cold head is not being regenerated, "OFF" will be displayed in the Regeneration Status and Time area. If the system is at high vacuum, and the cold head temperature rises above 22 Kelvin, "REGEN" will be displayed. If the cold head is being regenerated, the time remaining for the regeneration sequence will be displayed.

In order to start the regeneration sequence, the operator must press the F01 key. "RUN" will appear in the regenerator box. Pressing the F01 key at any time before the regeneration period is over (30 Minutes) the regeneration will stop, and the cryopump compressor will restart.

Pressing F09 will return the operator to the vacuum mimic. Pressing F10 will return the operator to the main menu.

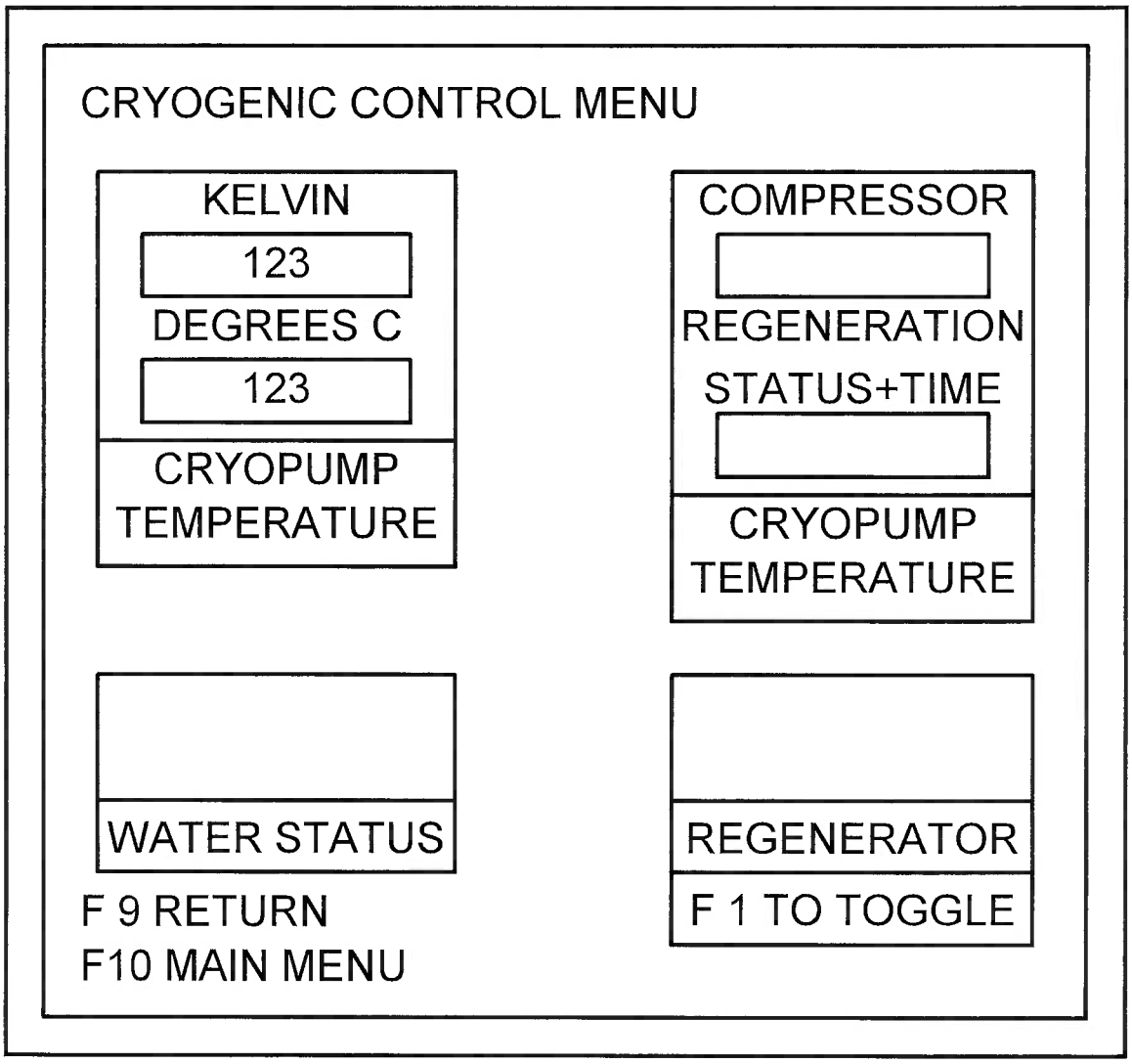

CRYOGENIC CONTROL MENU
KELVIN
123
DEGREES C
123
CRYOPUMP TEMPERATURE
COMPRESSOR
REGENERATION STATUS+TIME
CRYOPUMP TEMPERATURE
WATER STATUS
REGENERATOR
F 1 TO TOGGLE
F 9 RETURN
F10 MAIN MENU

FIGURE 12

7.8. THERMAL MIMIC.

Refer Figure 13.

The thermal mimic indicates the status of the active components used in the thermal system. The components which have independent mimics for more detailed information are:

F06 Thermal system heater output.
F06 Thermal system cooler output.
F06 Thermal system gas temperature.
F07 Fan motor temperature.
F07 Thermal system fan output.
F08 Dowthermal heater output.
F08 Dowthermal cooler output.
F09 Shroud temperatures.
F11 Dowthermal temperatures.

The following menus may be activated from the thermal menu:

F01 Skip Step. Selecting this function will force the system to execute the next profile step.
F02 Stop liquid mode. Selecting this function, stops the liquid mode.
F10. Main menu. Selecting this function will transfer the operator to the main menu.

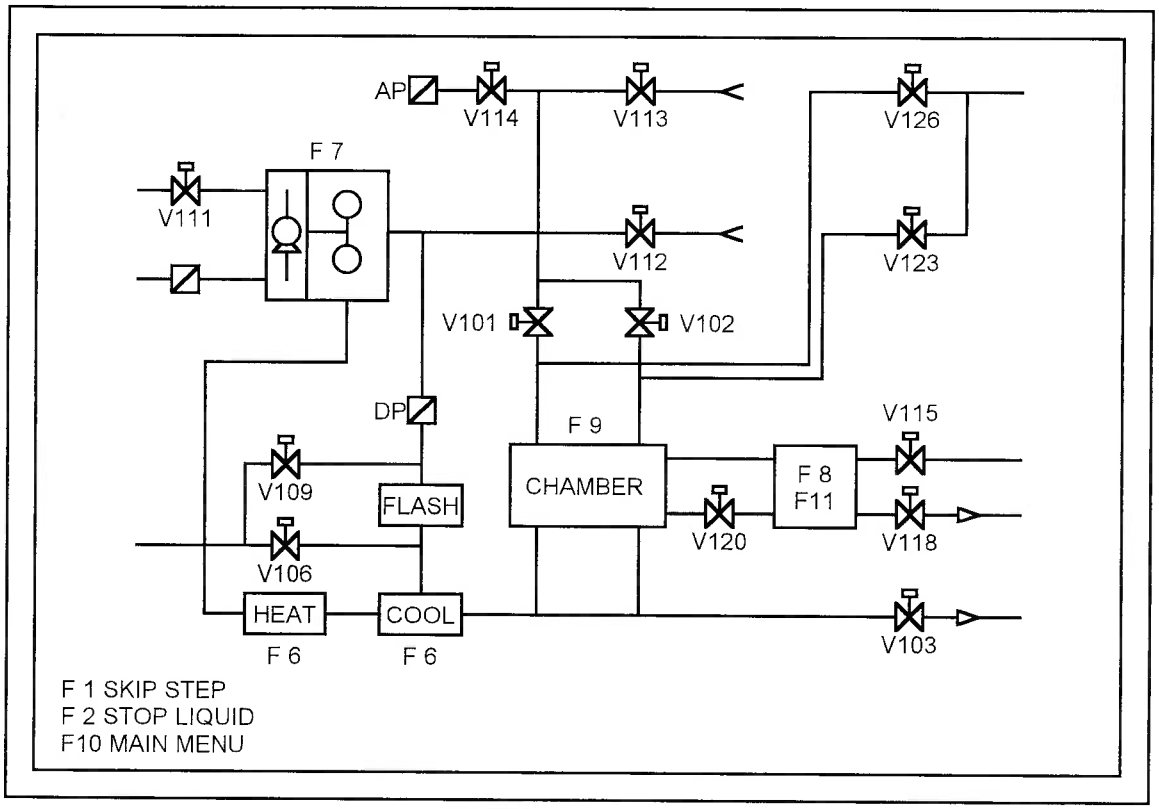


FIGURE 13

7.8.1 F06. Chamber thermal status

Refer Figure 14.

The following information is displayed:

- Gas temperature
- Current setpoint, this is the moving setpoint that increments by 1.5 degrees per minute.
- Final setpoint, this is the steady state setpoint that the system will stabilise at.
- Percentage cooler output.
- Percentage heater output.

Selecting F01 will force the system to execute the next thermal profile step.
Selecting F06 will return the operator to the thermal mimic.
Selecting F10 will return the operator to the main menu.

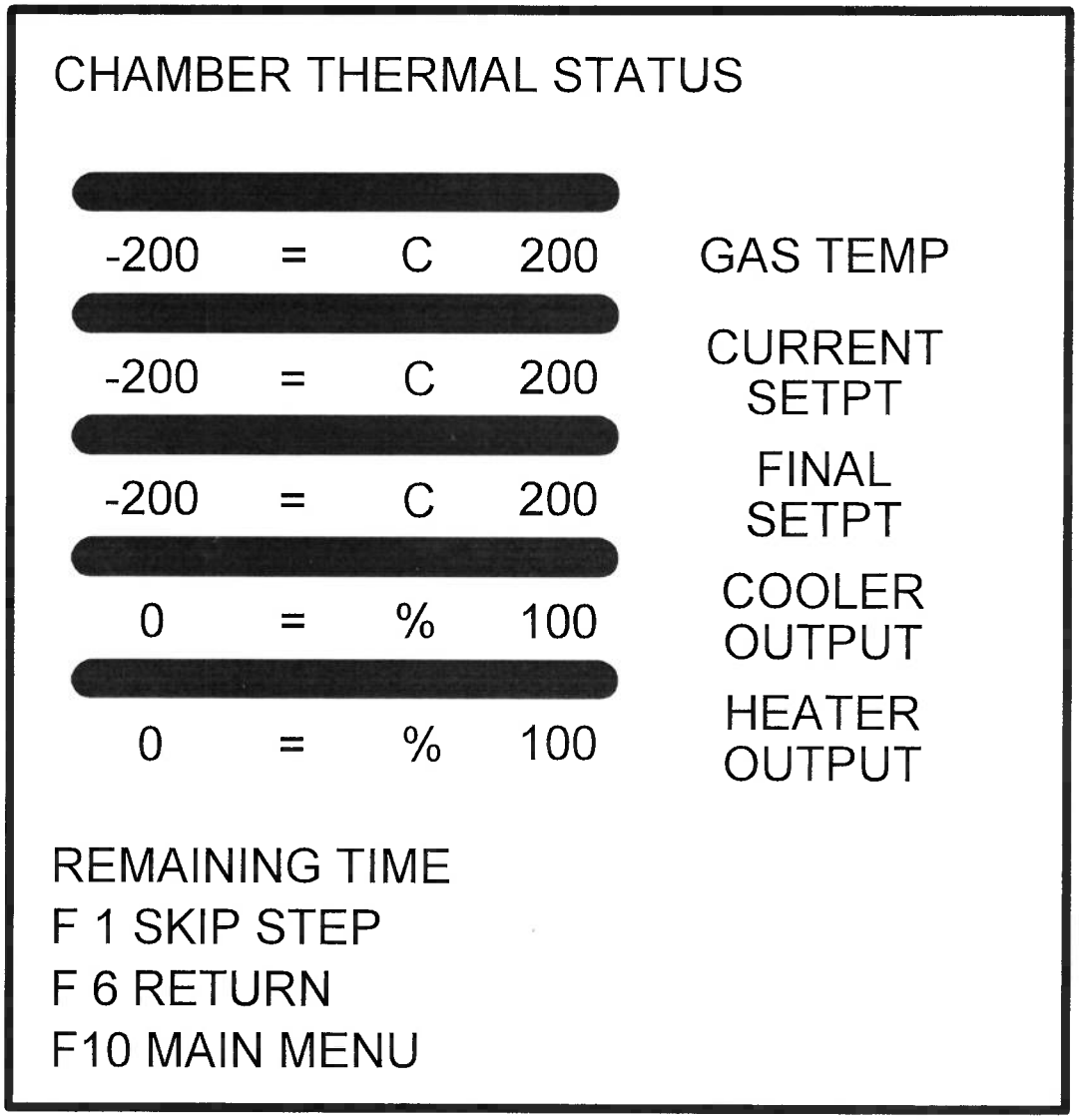

CHAMBER THERMAL STATUS
-200 = C 200
GAS TEMP
-200 = C 200
CURRENT SETPT
-200 = C 200
FINAL SETPT
0 = % 100
COOLER OUTPUT
0 = % 100
HEATER OUTPUT
REMAINING TIME
F 1 SKIP STEP
F 6 RETURN
F10 MAIN MENU

FIGURE 14

7.8.2 F07. Shroud thermal system. Refer Figure 15.

The following information is displayed:

The average shroud temperature, measured across all the shrouds.
The inlet temperature measured on the inlet of shroud 2.
The outlet temperature measured on the outlet of shroud 2.
The fan motor temperature measured on the fan motor.
Percentage cooler output as calculated by the PLC.

Selecting F07 will return the operator to the thermal mimic.
Selecting F10 will return the operator to the main menu.

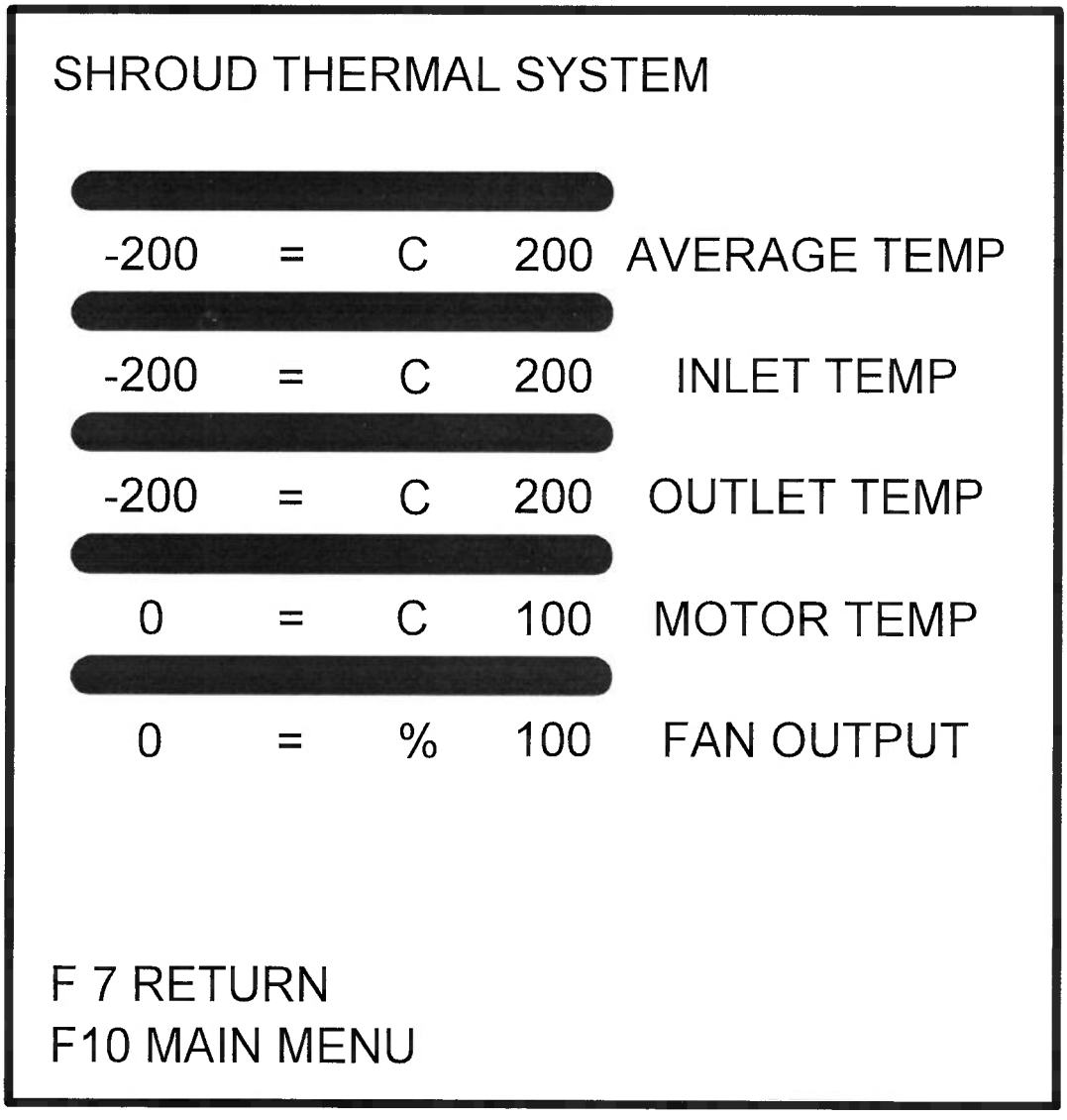


FIGURE 15

7.8.3 F08. Dowthermal status

Refer Figure 16.

The following information is displayed:

The average dowtherm temperature, measured on the test plate and in the dowtherm liquid.
Current setpoint, this is the moving setpoint that increments by 1.5 degrees per minute.
Final setpoint, this is the steady state setpoint that the system will stabilise at.
Percentage cooler output to the dowtherm system.
Percentage heater output to the dowtherm system

Selecting F01 will force the system to execute the next dowthermal profile step.
Selecting F08 will return the operator to the thermal mimic
Selecting F10 will return the operator to the main menu.

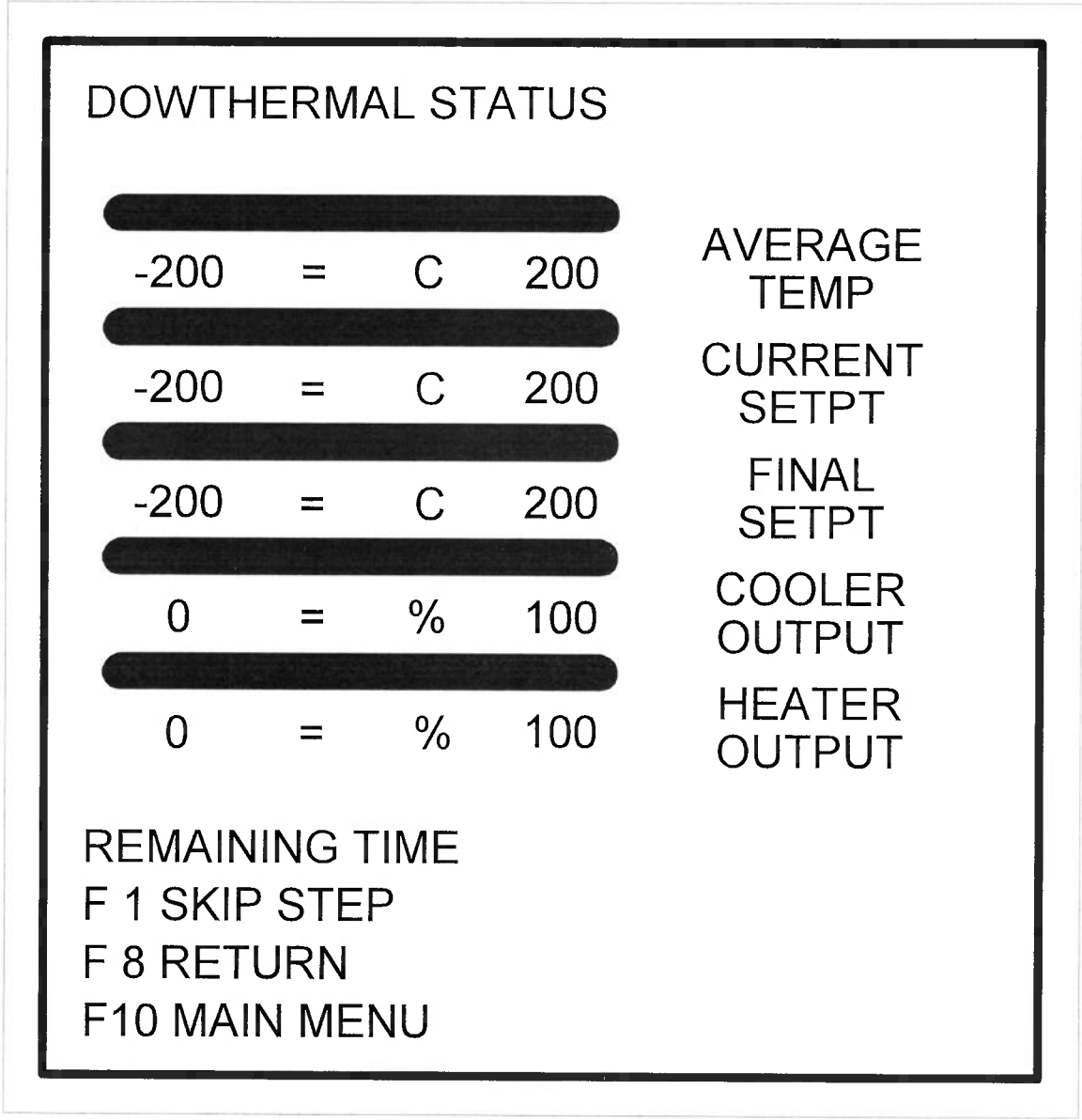


FIGURE 16

7.8.4 F09. Shroud temperatures.

Refer Figure 17.

The following information is displayed:

PT A The temperature measured on the door shroud.
PT B The temperature measured on the outlet of shroud 2.
PT C The temperature measured on the inlet of shroud 2.
PT D The temperature measured on the rear shroud.
Average, an average of all four shrouds.

Selecting F09 will return the operator to the thermal mimic.
Selecting F10 will return the operator to the main menu.

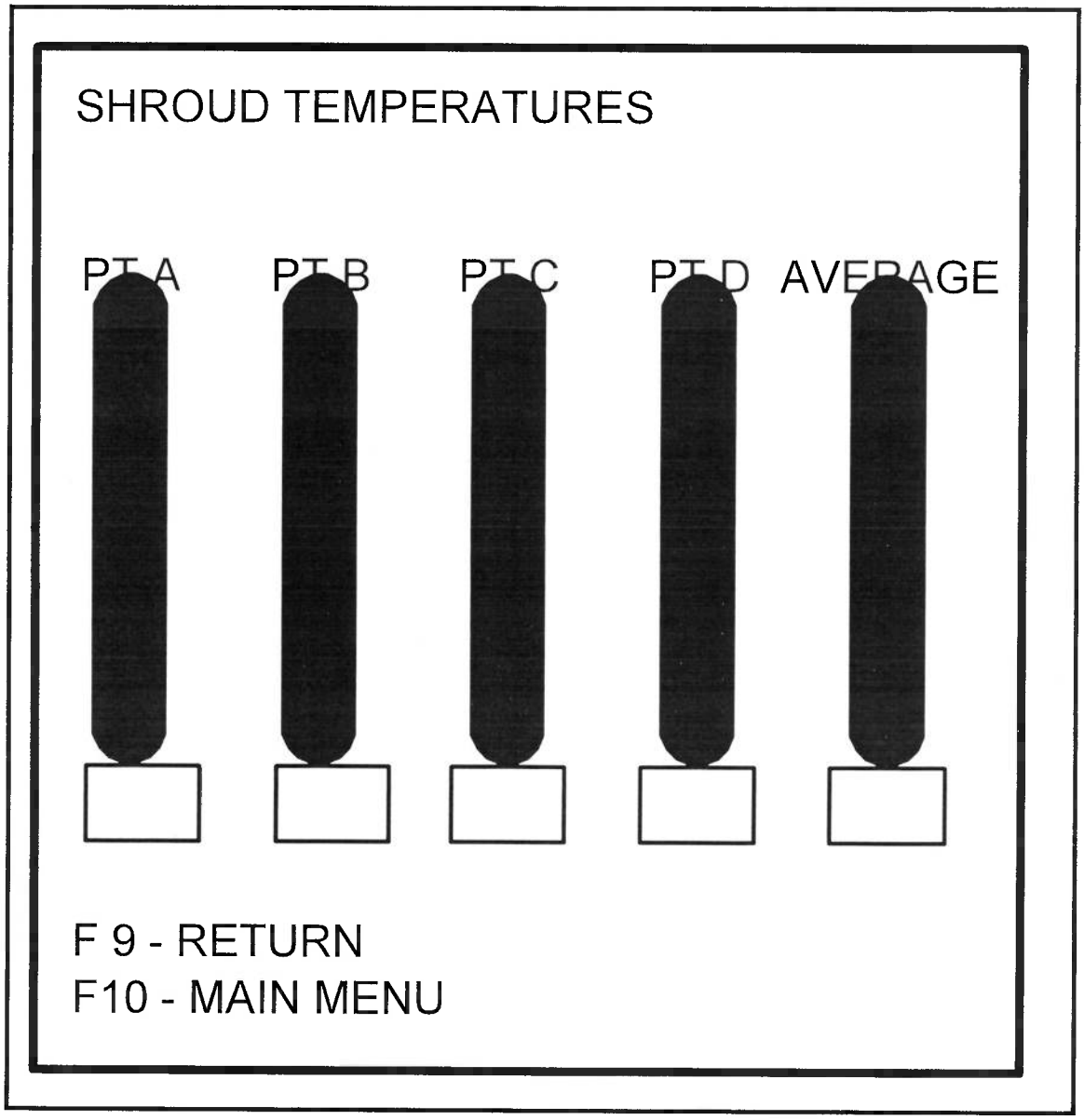


FIGURE 17

7.8.5 F11. Dowthermal temperatures.

Refer Figure 18.

The following information is displayed:

PT E The temperature measured on the loose user probe.
PT F The temperature measured on the dowthermal plate.
Dowtherm The temperature of the dowtherm liquid.
Fan The temperature measured on the fan motor.
Average, an average of PT F and the Dowtherm liquid.

Selecting F11 will return the operator to the thermal mimic.
Selecting F10 will return the operator to the main menu.

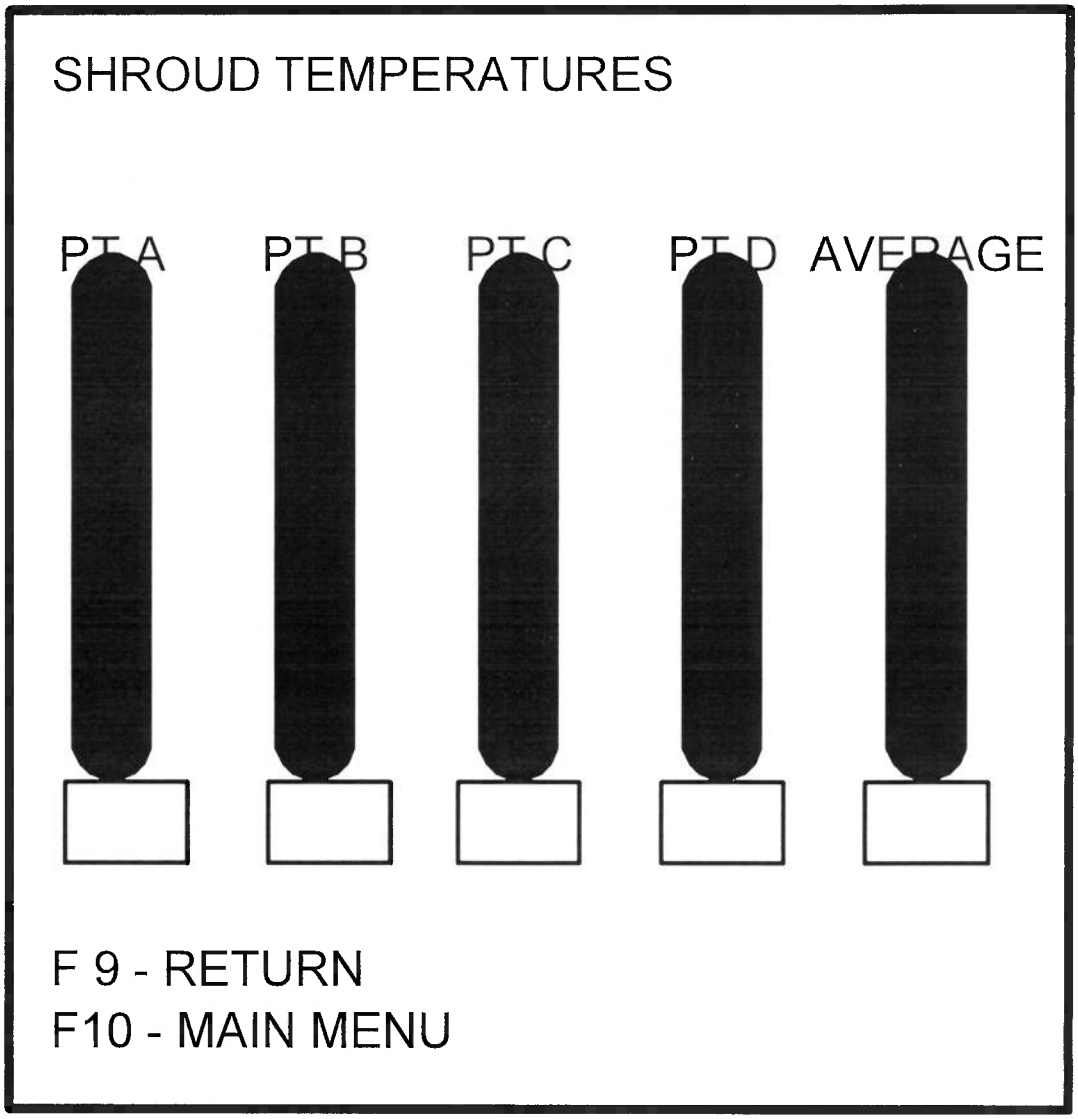

SHROUD TEMPERATURES
PT A
PT B
PT C
PT D
AVERAGE
F 9 - RETURN
F10 - MAIN MENU

FIGURE 18

SECTION 4

MAINTENANCE INSTRUCTIONS FOR THE MEDIUM THERMO-VACUUM FACILITY

1. INTRODUCTION

The maintenance requirements for the Vacuum System, Thermal System and Control System are given in the tables included in this paragraph.

The tables prescribe the required routine/preventative measures to be taken to maintain the system operatable. Guidelines are also given for breakdown repair. Detail instructions to follow are available in the refered documents/catalogues. Simple and logic maintenance actions like checking a valve operation etc, are not supported by detail instructions

Note: **The descriptions given in the tables ask for "what" to do and not "how" to do. The "How" to do are given in the refered documents/catalogues. This maintenance instructions cover only the maintenance prescriptions of the Major Functional Components and sub-components of the system.**

Maintenance intervals (time in hours, months, years, etc) refer to actual operating time. When the system is not in operation for long periods, certain maintenance is also required.

Where maintenance time intervals (hours, months, years, etc.) are not given direct or indirect, symtoms will indicate when necessary maintenance/repair is required. The catalogues often refers to such symtoms.

Warning: **The client is responsible to keep his own appropriate logbook(s) of individual components, systems, sub-systems, etc.**

The Maintenance Instructions are given in the following tables:

1. Table A : VTFM - Maintenance Descriptions for the Vacuum System
2. Table B : VTFM - Maintenance Descriptions for the Thermal System
3. Table C : VTFM - Maintenance Descriptions for the Control System

MAINTENANCE INSTRUCTIONS FOR MEDIUM THERMO-VACUUM FACILITY

TABLE A	MAINTENANCE INSTRUCTIONS FOR VACUUM SYSTEM			
GROUP	**ITEM DESCRIPTION**	**PREVENTATIVE MAINTENANCE**	**BREAKDOWN REPAIR**	**REFERENCE**
1. Forepump system	1.1 Pump D40B Trivac Rotary Vane Vacuum Pump (P3)	1.1.1 - Check the oil level frequently - Change oil after first 100 hours of operation and then after every 2000 - 3000 hours of operation 1.1.2 Cleaning the Dirt Trap 1.1.3 Cleaning or replacing the internal demister	A falling oil level in the oiler is a sign of malfunctioning outer shaft seal, that must be replaced. In case of further breakdown, repair or refer to the supplier, Leybold	VTFM-20000-128-01/1
	1.2 Exhaust Filter Unit (EFI)	**<u>Caution</u>: Hazardous substances may escape from the filter, condensate or the oil. Take suitable precautions (e.g. gloves, goggles or gas mask).** 1.2.1 Drainage of oil at regular intervals 1.2.2 Replacement of filter elements at regular time intervals 1.2.3 Drainage of condensate traps at regular intervals	In case of breakdown repair or replace as required	VTFM-20000-128-01/2
	1.3 Pump 2 Ruvac Roots Vacuum Pump WSU151	1.3.1 - Check the oil level frequently - Change oil after first 500 hours of operation, and then after every 3000 hours of operation 1.3.2 Cleaning the dirt trap 1.3.3 Cleaning the pump chamber	A falling oil level in the oiler is a sign of mal- functioning radial shaft seals, that must be replaced. In case of further serious breakdown,	VTFM-20000-128-02/1

MAINTENANCE INSTRUCTIONS FOR MEDIUM THERMO-VACUUM FACILITY

TABLE A			MAINTENANCE INSTRUCTIONS FOR VACUUM SYSTEM				
GROUP		ITEM DESCRIPTION		PREVENTATIVE MAINTENANCE		BREAKDOWN REPAIR	REFERENCE
				1.3.4	Test cooling water supply frequently (Pressure: 2 - 5 bar) (Consumption: 200 l/h)	repair or refer to the supplier, Leybold/ Krisch	
		1.4	Adsorption Trap FA 30-60			When the trap begins to deteriorate considerably in its effectiveness, it is time to **change the zeolite**	VTFM-20000-128-31/2 VTFM-20000-128-01/1
2	High Vacuum Pumping System	2.1	Cryopump (P1) RPK 1500 U3	2.1.1	Replacing the charcoal adsorber and the displacers.	In case of breakdown, refer to supplier, Leybold to repair or replace as required	VTFM-20000-128-03/1 VTFM-20000-128-03/2 VTFM-20000-128-03/3
		2.2	Compressor RW_2 (HCl)	2.2.1	Rinsing and filling the refrigerator with Helium	In case of breakdown, refer to supplier, Leybold to repair or replace as required.	VTFM-20000-128-03/1 VTFM-20000-128-03/2
3	Pressure Measuring and Controlling Instruments	3.1	Combitron CM351 combination Pirani/Penning measuring system			If it becomes necessary to equip the unit with a new software version, replace the EPROM In case of breakdown, replace or refer to the supplier, Leybold to repair	VTFM-20000-128-08/1 VTFM-20000-128-08/2

MAINTENANCE INSTRUCTIONS FOR MEDIUM THERMO-VACUUM FACILITY

TABLE A		MAINTENANCE INSTRUCTIONS FOR VACUUM SYSTEM		
GROUP	**ITEM DESCRIPTION**	**PREVENTATIVE MAINTENANCE**	**BREAKDOWN REAPIR**	**REFERENCE**
	3.2 PEH1 Penning Measuring Head Type PR35	3.2.1 Cleaning of the guage head in general	In case of breakdown repair or replace as required	VTFO-20000-128-15/1
		3.2.2 Mechanical Maintenance: - Removing the anode ring and the cathode plate to clean or replace **Note: The ceramics disc must be exchanged each time the anode ring or cathode plate is exchanged or cleaned** - Detaching the permanent magnet to clean or replace		VTFO-20000-128-15/2 VTFM-20000-128-08/2
	3.3 PH1 and PH2. Pirani Sensing Head Type TR301	3.3.1 Clean the Thermovac Gauge Head in general **Important: Do not clean the sensing tube mechanically (brush or similar) beacuse this damages the sensing filament**	In case of breakdown repair or replace as required	VTFO-20000-128-16/1 VTFM-20000-128-08/2

MAINTENANCE INSTRUCTIONS FOR MEDIUM THERMO-VACUUM FACILITY

TABLE B	MAINTENANCE INSTRUCTIONS FOR THERMAL SYSTEM			
GROUP	ITEM DESCRIPTION	PREVENTATIVE MAINTENANCE	BREAKDOWN REPAIR	REFERENCE
1 Gas re-circulation Fan		1.1 Annual visual inspection of the outer jacket 1.2 After the first 2000 operating hours, a full inspection of the electric motor, rotating impeller, cooling coil, etc, is required 1.3 After every year of operation a major inspection of the fan and all its internals in detail is required	In case of breakdown repair or replace as required **Warning: Ensure that the fan is electrically isolated and that the cooling water supply is switched off**	VTFM-30000-128-01/1
2 Heater Unit		2.1 Annual visual inspection of the heating elements 2.2 Check the heater elements electricaly on the outside for "burn outs", every 3 months of operation 2.3 After every year of operation the heater and its internals must be inspected in detail	In case of breakdown repair or replace heater unit elements **Warning:** Ensure that the isolation valve at the liquid nitrogen storage tank is closed and that there is no pressure in the liquid nitrogen pipeline	
3. Cooler unit			In case of breakdown or deteriorating perfor-mance clean or re-place the injection unit nozzles	VTFM-30000-128-01/1

MAINTENANCE INSTRUCTIONS FOR MEDIUM THERMO-VACUUM FACILITY

TABLE B	MAINTENANCE INSTRUCTIONS FOR THERMAL SYSTEM				
GROUP	ITEM DESCRIPTION		PREVENTATIVE MAINTENANCE	BREAKDOWN REPAIR	REFERENCE
				<u>Warning</u>: Ensure that the isolation valve at the liquid nitrogen storage tank is closed and that there is no pressure in the liquid nitrogen pipeline	
4. Piping system				In case of gas leak tighten the bolts or replace the seal	
5. Valves	5.1	Safety valve V113	5.1 Annual testing and pressure setting to 6,5 bar gauge. To b e tested by supplier (Bestobell)		
6. Pressure Vessels General	6.1	Thermal System Pressujre Boundary include: - Fan housing - Heater housing - Cooler housing - Pipework and Manufolds - Shrouds	6.1 Regular pressure tests to comply to Reg. of MOS. ACt. 6: 1983		
7. Dowtherm Thermal System	7.1	Dowtherm J, Fluid Pump	7.1.1 Check the state of the impeller and shaft support bearings on regular basis and ensure that the pump stay in a good condition	In case of breakdwon repair or replace as required	VTFM-30000-128-02/1

MAINTENANCE INSTRUCTIONS FOR MEDIUM THERMO-VACUUM FACILITY

TABLE B		MAINTENANCE INSTRUCTIONS FOR THERMAL SYSTEM			
GROUP	ITEM DESCRIPTION	PREVENTATIVE MAINTENANCE		BREAKDOWN REPAIR	REFERENCE
	7.2 Dowthermal Pipework			In case of a dow-therm leak, tighten the bolts or replace the seal	
	7.3 Dowtherm Tank	7.3.1	Top the Dowtherm level up frequently **Warning: Do not open the tank-lid during a cold cycle**		
	7.4 Heater elements	7.4.1	Electrical check for "burn outs" in case of bad performance		

MAINTENANCE INSTRUCTIONS FOR THE MEDIUM THERMO-VACUUM FACILITY

TABLE C		MAINTENANCE INSTRUCTIONS FOR CONTROL SYSTEM			
NO	ITEM	MODEL	DESCRIPTION	PREVENTATIVE MAINTENANCE	BREAKDOWN REPAIR
	Refer VTFM 42000-08				
1	11	TSX 67420	PROCESSOR UNIT	NONE	TELEMECANIQUE
2	11	TSX SUP702	POWER SUPPLY	NONE	TELEMECANIQUE
3	11	RKN 82	8 SLOT RACK UNIT	NONE	TELEMECANIQUE
4	20	TSX ASR 402	4-20 mA 4 CHANNEL	RECOMMEND ANNUAL CALIBRATION	TELEMECANIQUE
5	21	TSX AEM 811	ANALOG 8 CHANNEL	RECOMMEND ANNUAL CALIBRATION	TELEMECANIQUE
6	22	TSX DET 3212	DISCRETE 24 VDC	NONE	TELEMECANIQUE
7	23	TSX DST 3292	DISCRETE 24 VDC	NONE	TELEMECANIQUE
8	19	TSX SCM 2011	2 CHANNEL RS232	NONE	TELEMECANIQUE
9	14	XBTVB	OPERATOR DIALOG	CLEAN KEYBOARD WITH SOAP ONLY	TELEMECANIQUE
10	13	BT-H1450Y	RGB/VIDEO MONITOR	CLEAN DISPLAY WITH SOAP ONLY	NATIONAL
11	18	LRX -200 TO 200	3 WIRE PT100 TX	RECOMMEND ANNUAL CALIBRATION	EMMANUEL ELEC.
12	16	IAL4-00014	24 PIN I/O CARD	NONE	IST
13	15	VTFM-42035	24 VOLT PSU	NONE	IST
14	17	EMG 10-KSR	24V RELAY	NONE	PHOENIX
15	2	HU1	HEATER UNIT	NONE	LEYBOLD
16	3	CM351	VACUUM INST.	RECOMMEND ANNUAL CALIBRATION	LEYBOLD
17	4	LTI10	TEMPERATURE INST	NONE	LEYBOLD
18	5	EVEREX 386	COMPUTER	NONE	HP
19	6	HP	VGA SCREEN	CLEAN DISPLAY WITH SOAP ONLY	HP

MAINTENANCE INSTRUCTIONS FOR THE MEDIUM THERMO-VACUUM FACILITY

TABLE C		MAINTENANCE INSTRUCTIONS FOR CONTROLSYSTEM			
NO	ITEM	MODEL	DESCRIPTION	PREVENTATIVE MAINTENANCE	BREAKDOWN REPAIR
	Refer VTFM -45000-08				
20	13	VARISPEED 3KW	3KW VARIABLE SPEED	RECOMMEND ANNUAL CALIBRATION	VARISPEED
21	2	PHASECON 8KW	8KW THYRISTOR	RECOMMEND ANNUAL CALIBRATION	PHASECON
22	1	4-20mA,20-100KPA	I TO P CONVERTER	RECOMMEND ANNUAL CALIBRATION	EMMANUEL ELEC.
23	14	SHIMANDEN SR24	PID LOOP CONTROLLER	NONE	N.I.C.
24	15	SHIMANDEN SR24	PID LOOP CONTROLLER	NONE	N.I.C.
	Refer VTFM 44000-08				
25	16	PHASECON 12KW	12KW THYRISTOR	RECOMMEND ANNUAL CALIBRATION	PHASECON
26	25	0-10 BAR	OVER PRESSURE TRIP	NONE	ASCO
27	8	PRESET 0.75 KW	OVER CURRENT TRIP	NONE	BRUBIN ENG.
28	7	24V AIR SOLENOID	AIR CUT-OFF VALVE	NONE	ASCO
29	22	DRI-CUT	CUT-OUT RELAY	NONE	BRUBIN ENG.

SECTION 5

TROUBLE SHOOTING

1. INTRODUCTION

This section provides information for the identification and solution of all major failures experienced on the medium thermo-vacuum facility.

The failure symptom or problem, actual failure or fault, detection method, probable cause and solution to the failure or fault is given in the tables hereto.

The tables are given in the following order:

1. Vacuum System
2. Thermal System
3. Main Control and Data Acquisition System
4. Dowtherm System

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

VACUUM SYSTEM

PROBLEM/ SYMPTOM	FAILURE/ FAULT	DETECTION/ METHOD	PROBABLE CAUSES	SOLUTION/ REMEDY	REMARKS/ REFERENCES
1. LOSS OF HIGH VACUUM	1.a Failure of helium compressor - slow pumping speed - stop working	1a - Temperature rise of cryo-pump head	1.a - Helium leak	1.a - Detect leak repair and refil compressor	Refer to catalogues
		- Low He pressure on pressure gauge	- Broken/damaged helium compressor	- Connect affected cryo-pump with any other helium compressor	
		- "No-moving" He pressure gauge needle	- Overheat (self protection)	- Automatic reset after 3 hours	
				- Check water supply, restore if necessary	
		- Audio sensing	- Electrical Power failure	- Check control signal, repair if necessary	
			- Faulty control signal	- Check control signal, reapir if necessary	
	1.b Cryogenic cold head failure (stop working)	1.b - Audio sensing by ear	1.b - Broken/damaged helium compressor	1.b - Refer to failure of helium compressor (1a)	

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

VACUUM SYSTEM				
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**PROBABLE CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
		- Rise in temperature	- Broken/damaged cold heat	- Return to supplier for repair, or repair by qualified Technician	
	1.c Isolation valve(s) failure (Unexpected valve switching)	1.c - Check valve status on control panel - Visual/physical check of valve status	1.c - Broken/damaged valve - No control signal - No compressed air	1.c - Repair broken valve - Restore control signal - Restore compressed air	Refer to catalogues
	1.d - Vacuum leak (developed)	1.d - Detect gas composition/leak using RGA - Assumption of vacuum leak if failure is not due too one of other failures	1.d - Leaking seals - Latent leaks open - Structural fatigue - Electrical feadthrough leak	1.d - Replace defective seals: **Note: Defective seals can be temporally sealed with putty** - Repair leak or structural damage - Replace defective electrical feadthrough	

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

VACUUM SYSTEM								
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**		**DETECTION/ METHOD**		**PROBABLE CAUSES**		**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
	1.e	Cryo-pump saturated	1.e -	Test accordance with saturation test procedure	1.e -	Capacity limitation	1.e - Clean by regeneration	Refer to paragraph in this manual for procedure "Regeneration" of Cryopump
			-	Second stage cold heat temperature rise	-	Switched on at a too high pressure initially		Cryopumps
					-	operate at too high pressure for too long		
	1.f	Vacuum measurement system failure	1.f -	Compare Penning vacuum reading with Viscovac reading	1.f -	Dirty Penning sensing head	1.f - Service Penning head	
					-	Faulty penning sensing head	- Repair/replace Penning sensing head	
					-	Damaged cables	- Repair cables	
					-	Faulty vacuum instrument (Combitron)	- Repair/replace vacuum instrument	
					-	Software error on PLC system	- Rectify error on PLC system	

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

VACUUM SYSTEM									
PROBLEM/ SYMPTOM		**FAILURE/ FAULT**		**DETECTION/ METHOD**		**PROBABLE CAUSES**		**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
	1.g	Thermal plate (Dow-therm) leak	1.g	- Check Dowtherm level - Smelling Dow-therm at outlet of forepump unit when cryopump is regenerated	1.g	- Latent leaks open - Structural leaks open	1.g	- Devacuate and repair leak or structural damage	
2. UNABLE TO ACHIEVE HIGH VACUUM	2.a	Under performance of high vacuum pump system (un-able to achieve low temperatures on cryopump cold heads)	2.a	- Check tempera-ture of cold heads (to be lower than 13°K)	2.a	- Failure of helium compressor (refer to 1(a) above - Cryogenic cold head failure (refer to 1(b) above) - Contaminated helium if non of other causes - Contaminated cold heads	2.a	- Refer to failure of helium compres-sor 1(a) above - Refer to 1(b) Cryo-genic cold head failure - Replace with clean helium - Clean cold heads by regeneration - Clean cold heads in accordance with cleaning proce-dure (special activity)	

VACUUM SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**PROBABLE CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
	2.b - Contaminated vessel	2.b - Contamination level determined in accordance with procedure Houwteq doc no - RGA determine volatile materials - FTC measuring condensable materials	2.b - Contamination due to open vessel	2.b - Clean vessel in-accordance with cleaning procedure doc no	
	2.c Excessive high out-/ degassing of experiment	2.c - Contamination level detmined in accordance with procedure Houwteq doc no - RGA determine volatile materials - FTC measuring condensable materials	2.c - Material characteristics	2.c - To be decided by user, eg. use other material(s)	

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

VACUUM SYSTEM									
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**		**DETECTION/ METHOD**		**PROBABLE CAUSES**		**SOLUTION/ REMEDY**		**REMARKS/ REFERENCES**
	2.d	External leak	2.d -	Detect gas composition by RGA (high O_2 and M_2 or tracer gas levels)	2.d -	Leaking seals	2.d -	Replace defective seals. **<u>Note</u>: Defective seals can be temporally sealed with putty**	Follow procedure Houwteq doc no "Procedure to find and repair a vacuum leak in the thermal vacuum facility
					-	Latent leaks open	-	Repair leak or structural damage	
					-	Structural faituge			
					-	Electrical penetration leak	-	Replace defective penetration	
	2.e	Internal leak	2.e -	Detect gas composition by RGA (for shrouds)	2.e -	Leaking shroud	2.e -	Locate and repair leak on shroud	"Follow procedure to find and repair a vacuum leak in the thermal vacuum facility Houwteq doc no
			-	Detect gas composition by RGA (experiment)	-	Experimental leak	-	To be decided by user	
	2.f	Thermal plate (Dowtherm leak)	2.f -	Check Dowtherm level	2.f -	Latent leaks open	2.f -	Repair leak or structural damage	
			-	Smelling Dowtherm at outlet of forepump system	-	Structural leaks open			

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

VACUUM SYSTEM									
PROBLEM/ SYMPTOM		**FAILURE/ FAULT**		**DETECTION/ METHOD**		**PROBABLE CAUSES**		**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
3. SUDDEN CHANGE OF GAS COMPOSITION INSIDE VESSEL	3.a	Unexpected experimental degassing/ outgassing or internal leak	3.a -	Detect by RGA	3.a -	Experimental characteristics	3.a -	To be decided by user (engineering and scientific analysis and synthesis)	
	3.b	Unexpected leak development	3.b -	Detect by RGA	3.b -	As per internal and external leaks 2(d) and 2(e)			
	3.c	Faulty RGA sensing head	3.c -	Indicated by RGA instrument (this statement to be verify)	3.c -	Inherent cause	3.c -	Replace, repair or couple additional/ spare RGA sensing head to instrument port	
4. UNABLE TO START VACUUM SYSTEM	4.a	Software error	4.a -	See mimics XBT	4.a -	Error XBTL-900 software	4.a -	Correct error	
			-	Interlock active	-	Refer interlocking flow diagram	-	Correct error	
			-	Check communication signal from PLC to Combitron and Termovac (ref Remote indication)	-	PLC off line	-	Panic abord	
					-	PLC not initialised			

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

VACUUM SYSTEM									
PROBLEM/ SYMPTOM		**FAILURE/ FAULT**		**DETECTION/ METHOD**		**PROBABLE CAUSES**		**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
	4.b	Electrical supply failure	4.b -	Check voltage at Interface and sub panels	4.b -	Main supply off	4.b -	Restore electrical supply	
					-	Isolation switch off	-	Switch isolation on	
					-	Trip switch(es), solonoid(es) or fuse(s) activated (short circuiting)	-	Find short circuit starting testing at relevant compo-nents	
	4.c	Control Signal Failure	4.c -	Measure at point of control	4.c -	Faulty cable	4.c -	Repair or replace cable	
					-	Loose connections	-	Fix cables at con-nector blocks	
					-	Relay faulty	-	Test for short cir-cuiting and replace fuse	
5. STRANGE NOISES	5.a	Gas ballast open of rotary vane pump	5.a -	See ballast valve status on rotary van pump	5.a -	Valve was opened for cleaning oil of pump	5.a -	Close valve by hand	

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

VACUUM SYSTEM				
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**PROBABLE CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
	5.b Faulty forepumps	5.b - By ear, friction like noise	5.b - Pump turn wrong direction	5.b - Correct electric supply for correct phase coupling	Refer to Catalogues
			- Contaminated with dirt	- Clean pump(s) out. Replace components which are damaged. Remove/repair source of contamination	
			- Worn pump	- Service pumps, replace parts which are out of specification	
6. FAST SATURATION OF CRYO-PUMPS	6.a Dirty vessels	6.a - RGA composite evaluation	6.a - Vessel was not thoroughly cleaned out before starting evacu-ation	6.a - If it's impossible to de-evacuate, start regenerative process/cycle	
				- If de-evacuation is possible, cleanout vessel according to procedure	See Houwteq doc no

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

VACUUM SYSTEM									
PROBLEM/ SYMPTOM		**FAILURE/ FAULT**		**DETECTION/ METHOD**		**PROBABLE CAUSES**		**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
	6	Leaking vessel	6.b	- RGA composite evaluation; high percentage of O_2 or N_2	6.b	- Leaking valve - Leaking seal(s) - Leaking shroud - Leaking of base material, eg. weld, etc.	6.b	Replace and/or repair as per 2(d) or 2(e)	Follow procedure: "Procedure to find and repair a leak in thermal vacuum facility" Houwteq doc no
	6.c	High degassing/outgassing rate of equipment under test	6.c	- RGA composite evaluation - FTC output evaluation	6.c	- Wrong material - Dirty equipment	6.c	- Use correct (low outgassing) material - Clean equipment before thermal vacuum test, follow procedure doc no	
7 CRYO PUMP STOP WORKING (CRYO HEAD TEMPERATURE GOES UP)	7.a	He-compressor faulty	7.a	- He-compressor overheat warning light on	7.a	- Unsufficient cooling water supply - Sytem He pressure too high	7.a	- Restore correct cooling water supply - Below down He to specified pressure	

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

VACUUM SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**PROBABLE CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
		- He-compressor not running	- Faulty electrical power supply	- Restore electrical power supply	
			- Faulty "remote" control signal	- Restore electrical control signal	
			- Faulty "local" control	- Repair local control unit	
		- He-compressor to high	- Too much He in compressor	- Blown down He to specified pressure	
	7.b Cold head faulty	7.b - No hearing pumping action while He compressor works normally	7.b - Stuck piston because of contaminated He or loose particals	7.b - Clean and/or replace piston. This should be done by a trained technician	
	7.c Electrical power cut off	7.c - Measure electrical power supply to He-compressor and high vacuum control panel	7.c - Trip active or fuse blown be cause of too high electrical current consumption	7.c - Repair source of too high electrical current consumption	
			- Trip or fuse failure	- Repair trip or fuse	

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

VACUUM SYSTEM								
PROBLEM/ SYMPTOM		**FAILURE/ FAULT**		**DETECTION/ METHOD**		**PROBABLE CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
	7.d	Control signal failure	7.d	- Check for control signal at He-compressor and at cryopump head and check for short circuiting	7.d	- Faulty cable - Loose connection - Blown fuse - Faulty relay - Software error	7.d - Repair or replace - Fix cable/s at connector blocks - Replace fuse - Replace relay - Correct software	
8. CRYOPUMP UNABLE TO ACHIEVE CRYO TEM-PERTURE	8.a	"Pressure" inside vessel too high	8.a	Read Penning vacuum gauge	8.a	- "Dirty Vessel" - Leaking Vessel - High degassing/ outgassing rate of equipment under test	8.a - Refer to paragraph 6(a), 6(b) and 6(c) above	
	8.b	Too low He-pressure	8.b	- Check pressure gauge on He-compressor (to be min 16 bar)	8.b	- Helium leak on closed circuit	8.b - Refill if small leak - Repair leak and refil closed circuit	

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

VACUUM SYSTEM						
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**		**DETECTION/ METHOD**	**PROBABLE CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
	8.c	Faulty cold head	8.c - No hearing pumping action while He-compressor works normally	8.c - Stucked piston because of contaminated He or loose particals	8.c - Clean out or replace piston (This should be done by a trained technician)	
	8.d	Temperature sensor or temperature measuring instrument faulty	8.d - LTI indicates faulty sensor - Indication XBTL-9000 mimics - Couple dummy sensor to verify LTI performance	8.d - Cable failure - LTI failure - SDIO card failure	8.d - Check / test / replace	Ref LTI handbook
9. UNRELIABLE VACUUM READINGS (VARIATION IN READING FROM VACUUM PROBE "MAD READINGS")	9.a	Sensor isolated	9.a - Check vacuum valve status	9.a - Valve closed on purpose - Valve closed by mistake	9.a - Reset valve status	
	9.b	Sensor faulty	9.b - Replace sensor for comparison measurements	9.b - Dirty sensor - Loose connector or wires	9.b - Clean sensor - Fix connector to wires	

VACUUM SYSTEM								
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**		**DETECTION/ METHOD**		**PROBABLE CAUSES**		**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
			- Couple "faulty" sensor to non faulty measuring instrument and evaluate readings		- Broken sensor		- Replace sensor	
	9.c	Measuring instrument faulty (Combitron)	9.c - Change probe(s) coupled to measuring instrument and valuate reading(s)		9.c - Broken instrument - Loose wires/ connections - Short circuiting		9.c - Repair or replace - Fix wires/connectors - Repair circuiting	
	9.d	Faulty communication route	9.d - Measure communication route integrity		9.d - Damage cable(s) (physically) - Blown fuse		9.d - Repair or repalce (cable(s)) - Replace fuse	
	9.e	Faulty software (wrong readings at PLC or XBT)	9.e - If measuring instruments and PLC output readings differ, a software error is indicated		9.e - Accidental change of software - Loss of memory		9.e - Reprogram or reload correct program	

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

VACUUM SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**PROBABLE CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
10. SLOW PUMPING OF FORE VACUUM	10.a Some of fore-vacuum pumps not running	10.a - Check electric motor operation - It is possible that the pressure is too high for roots pump P2 to start	10.a - Electric motor power failure - Electric motor failure - Stuck pump because of loose particals or lack of oil - Leaking pipework or vessel	10.a - Repair electric power supply - Repair or replace electric motor - Clean out pump. Repair or replace damage compo-nents - Fix leak or start pump by manual control	
	10.b Bypass valve open	10.b - Check status at control panels or check visually at valve	10.b - Signal failure - Compressed air failure - Stuck valve - Damaged valve	10.b - Restore correct signal - Restore com-pressed air supply - Clean out valve - Repair or replace valve	

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

VACUUM SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**PROBABLE CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
	10.c Main vessel isolation valve V1 not fully open	10.c - Check status on valve position indicator (small pin will be out in valve full open position)	10.c - Signal failure - Compressed air failure - Stuck valve - Damaged valve - To high ΔP over valve	10.c - Restore correct signal - Restore compressed air - Clean out valve - Repair or replace valve - Equilize pressure across valve and switch valve to desired position	
	10.d Oil or Roughing pump P3 contaminated	10.d - Check oil colour	10.d - Contamination inside vessel	10.d - Replace oil - Clean vessel interior	
	10.e Exhaust blocked	10.e - Feel by hand low/ no gas stream at exhaust outlet at relative high pressure inside vessel	10.e - Exhaust pipe blocked by obstruction	10.e - Remove obstruction	

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

VACUUM SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**PROBABLE CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
	10.f Faulty pump	10.f - Uncoupled pumps for individual spinning tests	10.f - Damaged or weared motors or blades - Leaking or stucked internally non return valve in rotary vane pump P3	10.f - Repair or replace damaged components	
11. OVERHEATING OF COMPONENTS	11.a Cooling water supply failure	11.a - Wrong valve(s) status - No flow "Overall cooling flow indicator" feed back - No flow "Subsystem/component flow indicator" signal/feed back	11.a - Wrong switching or setting or valve failure - Recirculation pump or pipe system failure - Solenoid valve failure	11.a - Correct switching status - Repair cooling system - Repair or replace salonoid	

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

VACUUM SYSTEM									
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**		**DETECTION/ METHOD**			**PROBABLE CAUSES**			**SOLUTION/ REMEDY**			**REMARKS/ REFERENCES**
	11.b	Component cooling system failure	11.b	-	Water leak	11.b	-	Fatique or rust	11.b	-	Replace components	
				-	Restricted water through-put		-	Dirt in pipe line		-	Clean out pipe	
	11.c	Overload of component	11.c	-	Too high electrical current used	11.c	-	Wrong operational input or too high friction	11.c	-	Correct operational/performance requirement. Change PLC program	
				-	Typical "overload" noise					-	Service/replace component	
	11.d	Main cooling water too hot	11.d	-	Temperature measurement, high reading	11.d	-	Wrong or faulty temperature setting in water recirculation system	11.d	-	Set system for cooler recirculation water, or repair/replace faulty instruments	

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

THERMAL SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
1. LOSS OF PRESSURE.	1.a. - No supply of LN_2.	1.a. - Check LN_2 tank level gauge.	1.a. - Empty tank .	1.a. - Refill tank.	
	1.b. - Nitrogen tank pressure too low.	1.b. - Check pressure gauge on tank. (Pressure below 8 bar gauge). - Check line regulator correctly set.	1.b. - Tank pressure setting incorrect.	1.b. - Contact supplier.	
	1.c. - Pressure control system not functioning or functioning incorrectly.	1.c. - Check system pressure on XBTL-900 screen. - Check system pressure on pressure control unit on thermal system control panel. (TSCP) - Check pressure on pressure gauge PG 100.	1.c. - Incorrect pressure setting on pressure control unit in thermal system Control Panel (TSCP) - Faulty pressure control unit in thermal system control panel.	1.c. - Restore incorrect pressure setting on thermal system control panel (TSCP). - Contact supplier. - Replace faulty pressure control unit on thermal system control panel.	

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

THERMAL SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
	1.d. - Leak.	1.d. - Check for leaks on all flanges. - Check for pipe leaks audio or visual. - Check vacuum of vessel.	1.d. - Damaged or broken seals. - Loose bolts. - Fatigue. - Shroud leak.	1.d. - Fasten bolts. - Replace damaged seals. - Repair leak. - Repair leak	
	1.e. - Incorrect valve setting.	1.e. - Check valves to be closed V135, V103, V129 and V128. - Check if valves V123 and V126 are open. - Check safety valve to be closed V113.	1.e. - Incorrect signal from main control panel. - Manual valve in-correct position. - Damaged/broken valve.	1.e. - Restore incorrect signal on main control panel (software or hardware). - Adjust valve to correct position. - Replace damaged/broken valve.	

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

THERMAL SYSTEM				
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
2. THERMAL DEVIATION ON SINGLE SHROUD.	2.a. - Excessive or insufficient gas flow to the shroud.	2.a. - Single shroud temperature differs by more than 20° C from average temperature of remaining shrouds as indicated on the mimic display.	2.a. - Incorrect valve setting. Handvalve V101, V102. - Faulty valve.	2.a. - Repair/ Re-place valve.	
	2.b. - Ice blockage in shroud feeder pipes.	2.b. - Undetectable.	2.b. - Moisture in the system before going into cooling cycle.	2.b. - Allow system to return to ambient temp. - Initiate heating cycle and maintain at 100° C for 2 hours.	

MCP = Main Control Panel
IPT = Current Pressure Transmitter

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

THERMAL SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
	2.c. - LN_2 in the shroud.	2.c. - Excessive low temperature (-170° C) on single shroud as indicated on mimic display.	2.c. - Poor atomization of LN_2 in the cooler unit. - Sudden pressure drop in thermal system resulting in liquidizing of GN_2.	2.c. - Reduce maximum setting of valve V106. - Refer to loss of pressure - ref. 1. above.	
	2.d. - Unrealistically low shroud temperature.	2.d. - LED on PLC will be illuminated. - PT 100 readout on mimic screen will indicate -220°C.	2.d. - PT 100 failure.	2.d. - Replace faulty PT 100 unit.	
3. SLOW OR NON - RESPON- SIVE TRANSIENT.	3.a. - No supply of LN_2.	3.a. - Check LN_2 tank level gauge.	3.a. - Empty tank.	3.a. - Refill tank.	

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

THERMAL SYSTEM					
PROBLEM/ SYMPTOM	FAILURE/ FAULT	**DETECTION/ METHOD**	CAUSES	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
	3.b - No electrical power to heater unit.	3.b. - Check for signal on mimic display. - Check LED on thyristor. - Check current on power cable from thyristor to heater with clamp meter.	3.b - No signal from MCP. - No signal from thyristor. - Burntout heater element.	3.b - Restore signal on MCP. - Repair/replace faulty thyristor. - Replace heater element.	

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

THERMAL SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
	3.c. - Insufficient fan performance.	3.c. - No signal on variable speed controller on TSCP. - Audio detection. - Alarm indicator on mimic display.	3.c. - No electrical power to fan. - Damaged/ broken fan. - No cooling water supply. (Inter-locked, fan will not start) - Excessive motor temperature (>70° C). (Interlock on temperature)	3.c. - Restore electrical power to fan. - Repair/re-place faulty fan. - Restore cooling water supply. - Inspection on fan motor as per manual.	

TSCP = Thermal System Control Panel

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

THERMAL SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
	3.d. - Incorrect valve setting.	3.d. - Valve V101, V102 closed or to be closed. (See handle). - Valve V135 open or partly open. (Feel handwheel on valve)	3.d. - Wrong valve setting.	3.d. - Set valve(s) to correct setting.	

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

THERMAL SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
	3.e. - Nitrogen tank pressure too low.	3.e. - Check pressure gauge on tank. Pressure not to be below 8 bar gauge. - Check line regulator correctly set.	3.e. - Tank pressure setting incorrect.	3.e. - Contact supplier.	
	3.f. - Pressure control system not functioning or functioning incorrectly.	3.f. - Check system pressure on XBTL-900 screen. - Check system pressure setting on pressure control unit on thermal system control panel.(TSCP) - Check pressure on pressure gauge PG 100.	3.f. - Incorrect pressure setting on pressure control unit in thermal system control panel. (TSCP) - Faulty pressure control unit in thermal system control panel.	3.f. - Restore incorrect pressure setting on thermal system control panel. (TSCP) - Replace faulty pressure control unit on thermal system control panel. (TSCP) - Contact supplier	

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

THERMAL SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
	3.g. - Leak	3.g. - Check for leak on all flanges. - Check for pipe leaks audio or visual. - Check vacuum of vessel	3.g. - Damaged or broken seals. - Loose bolts. - Fatigue. - Shroud leak.	3.g. - Replace damaged seals. - Fasten bolts. - Repair leak. - Repair leak.	
	3.h. - Incorrect pressure control valve setting	3.h. - Check valves V135, V103 and V129 if closed.. - Check valve GN_2 supply if open. (Houwteg) - Check valve V123 and V126 for activeness..	3.h. - Incorrect signal from main control panel. - Manual valve in-correct position. - Damaged/ broken valve.	3.h. - Restore incorrect signal on main control panel (software or hardware). - Adjust valve to correct position. - Replace damaged/ broken valve. - Contact supplier	

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

THERMAL SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
	3.i. - Incorrect test profile.	3.i. - Incorrect un-expected re-sponse of transient profile on mimic display.	3.i. - Operator error.	3.i. - Correct error on test profile.	
4. STEADY STATE TEMPERA-TURE DRIFT	4.a. - Interrupted LN_2 supply to cooler unit..	4.a. - Check LN_2 tank level gauge. - Check tank pressure to be minimum 8 bar gauge. - Check cooler unit feed valve V106 for correct operation	4.a. - Empty tank. - Unsufficient pressure build-up in tank, because of too much GN_2 used elsewhere. - Stuck cooler unit feed valve V106.	4.a. - Refill tank. - Regain pressure in tank. - Repair/replace valve V106.	

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

THERMAL SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
	4.b. - Interrupted electrical power to heater unit.	4.b. - Check for signal on mimic display. - Check LED on thyristor. - Check current on powder cable from thyristor to heater with clamp meter.	4.b. - No signal from MCP. - No signal from thyristor. - Burnt out heater element.	4.b. - Restore signal on MCP. - Repair/replace faulty thyristor. - Replace heater element.	
	4.c. - Interrupted mass flow of recirculating N_2.	4.c. - ΔT on shrouds changed even with heater and cooler switched off. - Check for correct valve settings V101 and V102.	4.c. - Control hardware error, wrong valve setting(s), undesired valve switching or drift	4.c. - Change/repair control hardware - Re-programme - Change control parameters - Change control philosophy.	

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

THERMAL SYSTEM				
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
5. UNSTABLE STEADY STATE TEMPERA-TURE CONTROL.	5.a. - Excessive capacity on heater or cooler.	5.a. - Excessive fluctuation of shroud temperature from steady state temperatures as displayed on mimic screen.	5.a. - Maximum heater and cooler limit setting on PL 7 to high. - Incorrect PID settings on the heater or cooler.	5.a. - Reset maximum limit setting in PL 7 software. - Reset PID settings in XBTL-900 screen.	
6. UNACCEP-TABLE ΔT ACROSS SHROUDS.	6.a. - Too low N_2 mass flow through shrouds	6.a. - Wrong valve setting V101 and V102. - Alarm on mimic - Too low fan speed - Overload indi-cation of fan motor and for variable speed drive	6.a. - Error on electrical power to fan. - Damaged/broken fan. (electric motor, rotor or stator). - Wrong speed setting of fan - Restriction in flow path. (valve{s} closed or physical blocking by loose particle)	6.a. - Restore electrical power to fan. - Inspection on fan motor as per manual. - Correct fan speed setting. - Correct valve settings or clean blockage.	

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

THERMAL SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
	6.b. - GN_2 pressure in thermal system too low.	6.b. - Check LN^2 tank level gauge.	6.b. - Empty tank.	6.b. - Refill tank.	
		- Check pressure gauge on tank. (Pressure not below 8 bar gauge).	- Tank pressure setting incorrect.	- Contact supplier.	
		- Check line regulator correctly set.	- Leaking N_2 close loop.	- Leaktight system.	
	-	- Check for low system pressure on XBTL-900 screen.	- Incorrect pressure setting on pressure control unit inside TSCP.	- Restore incorrect pressure setting.	
		- Check system pressure on pressure control unit on thermal system control panel. (TSCP) - Check pressure on pressure gauge GP100.	- Faulty pressure control unit in TSCP.	- Contact supplier. - Replace faulty pressure control unit in TSCP.	

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

THERMAL SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
		- Check and listen for leaks on components and pipework	- Stuck or incorrect functioning of pressure control valves V112 and/or V123,V126 and/or LN_2 injection valve V106.	- Repair/clean out or replace valves	
	6.c. - Incorrect valve setting	- Check valves to be properly closed V128, V103 and V129. - Check valves to be open V104.	- Incorrect signal from main control panel. - Manual valve in correct position. - Damaged/broken valve	- Restore incorrect signal on main control panel (software or hardware). - Adjust valve to correct position. - Replace damaged/broken valve.	

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

THERMAL SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
	6.d. - LN_2 in the shroud .	6.d. - Excessive low temperature (-170° C) on single shroud as indicated on mimic display.	6.d. - Poor atomization of LN_2 in the cooler unit. - Sudden pressure drop in thermal system resulting in GN_2 to LN_2.	6.d. - Reduce maximum setting of valve V106 at low operating tempe-ratures. - Refer loss of pressure. Ref 1 above.	
7. ABNORMAL NOISES.	7.a. - Gas leak.	7.a - Audio. - Pressure loss on mimic display.	7.a. - Burst/ damaged pipe. - Loose connection.	7.a. - Repair leak. - Rectify connection.	
	7.b. - Chattering of solenoid valve.	7.b. - Audio.	7.b. - Faulty solenoid valve.	7.b. - Replace solenoid valve.	

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

THERMAL SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
	7.c. - Excessive noise on fan.	7.c. - Audio.	7.c. - Excessive thermal contraction/ex-pansion on components. - Unbalanced fan.	7.c. - Inspect fan assy and repair. - Reduce operating limits. - Balance fan.	
8. ICE FORMATION ON INSULATED COMPO-NENTS OR PIPES.	8.a. - Gas leak.	8.a. - Visual; excessive ice near leak under cold operating conditions..	8.a. - Damaged pipe. - Loose connection.	8.a. - Repair leak. - Rectify connection.	
	8.b. - Insufficient thermal protection.	8.b. - Visual, excessive ice near damaged insulation.	8.b. - Damaged insulation.	8.b. - Repair insulation.	

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

THERMAL SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
9. BAD SMELLS	9.a. - Burning insulation.	9.a. - Smelling/Smoke	9.a. - Unbalanced heater output vs. recirculated gas flow in closed loop.	9.a. - Reset PID on XBTL-900 screen. - Reduce maximum, setting for heater on PL 7 software.	
	9.b. - Electrical and electronic cable or component burn-out.	9.b. - Smell - Flame - Colour	9.b. - Electrical short circuiting - Overloading.	9.b. - Replace wire and/or affected component and repair cause.	
10. WATER VAPOUR CLOUDS.	10.a. - Gas leak during cold operating cycle.	10.a. - Visual.	10.a. - Burst/ damaged pipe. - Loose connection.	10.a. - Repair leak. - Rectify connection .	

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

THERMAL SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
11. EXCESSIVE PRESSURE	11.a. - Pressure control system failure OR undesired/spurious opening of LN_2 injection valves V106 and V109	11.a - Check system pressure on XBTL-900 screen. - Check system pressure on pressure control unit in TSCP. Check pressure on pressure gauge - PG 100. Opening of safety valve V113. -	11.a. - Incorrect signal from main control panel XBTL-900 screen. - Faulty pressure control unit in TSCP. - Stuck pressure control valve V112 - Stuck LN_2 injection valves V106 & V109	11.a. - Restore incorrect signal on main control panel (software or hardware). - Contact supplier. - Replace faulty pressure control unit in TSCP. - Repair or replace faulty valves.	
12. NO START AFTER ACTIVATION OF THERMAL SYSTEM.	12.a. - No power supply to thermal system.	12.a. - No indication on DB volt meter. - Tripped isolator. - Phase indicator on volt meter.	12.a. - Power failure. - Incorrect or no phase supply. - Overload/ short circuiting. - Blown fuses.	12.a. - Restore power supply. - Repair electrical faults. - Replace fuse.	

DB = Distribution board

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

THERMAL SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
	12.b. - Interlocks active (cooling water supply, valve settings, motor temperature and system pressure).	12.b. - Warning signal displayed on mimic screen.	12.b. - No cooling water supply. - Excessive fan motor temperature (>70° C). - Incorrect valve setting: * Incorrect signal from MCP. * Faulty IPT transmitter. * Faulty valve. - Insufficient system pressure.	12.b. - Restore cooling water supply. - Inspection fan electrical motor as per manual. - Restore valve setting * Restore incorrect signal on MCP. * Replace defector IPT transmitter. * Repair/ replace valve. - Activate purge cycle. If pressure setpoint not achievable, refer to 1. above - "Loss of Pressure".	

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

THERMAL SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
13. LED INDICATOR ON VSC FLASING.	13.a. - Overload on fan.	13.a. - Visual; LED indicator on VSC.	13.a. - Incorrect maximum limit settings of fan speed. - Faulty fan.	13.a. - Reduce maximum limit setting on PL 7 software to eliminate overload situation. - Inspection of fan assy.	
	13.b. - VSC faulty.	13.b. - Visual; LED indicator on VSC.	13.b. - Damaged/ broken VSC.	13.b. - Replace/repair VSC. (to be done by qualified Technician).	
14. ICE FORMATION ON VACUUM INSULATED PIPES.	14.a - Loss of vacuum.	14.a. - Visual, ice forming on pipe.	14.a - Leak on inner or outer pipe.	14.a - Repair leak. - Re-evacuate.	

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

THERMAL SYSTEM				
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
15. EXCESSIVE HEAT (>50° c) ON VACUUM INSULATED PIPES.	15.a. - Loss of vacuum.	15.a. - Feel by hand or measure with temp probe.	15.a. - Leak on inner or outer pipe.	15.a. - Repair leak. - Re-evacuate.	
16. PERSONNEL EXPERIEN-CE DIZZI-NESS AND NAUSEA.	16.a. - Lack of O_2 in test area.	16.a. - Verify N_2 conta-mination on N_2 indicator in test area. OR Low level O_2 alarm activated.	16.a. - Excessive N_2 leak in test area. - Opening of N_2 filled test vessel.	16.a. - Locate and repair leak. - Operators to wear protection equipment.	

VSC = Variable Speed Controller
LED = Light Emitting Diode

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

MAIN CONTROL & DATA ACQUISITION SYSTEM

PROBLEM/ SYMPTOM	FAILURE/ FAULT	DETECTION/ METHOD(S)	PROBABLE CAUSES	SOLUTION/ REMEDY	REMARKS/ REFERENCES
1. ELECTRICAL	1 V112 will not open	1 - 24 VDC at cut off valve 112 - 0 VDC at cut off valve 112 - O VDC at cut off valve 112 - O VDC at cut off valve 112 - O VDC at cut off valve 112 - >3.5 mA at V112 ITP - <3.5 mA at V112 ITP - >4 mA at V112 ITP	1 - Cut off V112 faulty - "Fuse 23 - Relay 27 MCP - Relay 14 ICP - PLC DST 3292 - V112 ITP - PID Pressure control - Valve 112	1 - Replac de cut off valve - Replace fuse - Replace relay - Replace relay - Replace card - Replace ITP - Replace controller - Replace valve	
	2 V109 will not open	2. - 24 VDC at cut off valve 109 - O VDC at cut off valve 109 - O VDC at cut off valve 109 - O VDC at cut off valve 109 - O VDC at cut off valve 109 - >4 mA at V109 ITP - <3.5 mA at V109 ITP - > 4 MA at V109 ITP	2 - Cut off V109 faulty - Fuse 22 - Relay 26 MCP - Relay 13 ICP - PLC DST 3292 card - V109 ITP - Flash level control - Valve 109	2 - Replace cut off valve - Replace fuse - Replace relay - Replace relay - Replace card - Replace ITP - Replace controller - Replace valve	

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

MAIN CONTROL & DATA ACQUISITION SYSTEM

PROBLEM/ SYMPTOM	FAILURE/ FAULT	DETECTION/ METHOD(S)	PROBABLE CAUSES	SOLUTION/ REMEDY	REMARKS/ REFERENCES
	3. V115 will not open	3 - 24 VDC at cut off valve 115	3 - Cut off V115 faulty	3- - Replace cut off valve	
		- O VDC at cut off valve 115	- Fuse 7	- Replace fuse	
		- O VDC at cut off valve 115	- Relay 11 MCP	- Replace relay	
		- O VDC at ut off valve 115	- PLC DST 3292	- Replace card	
		- > 4 mA at V115 ITP	- V115 ITP	- Replace ITP	
		- <3.5mA at V115 ITP	- PLC ASR 402 card	- Replace card	
		- >4mA at V115 ITP	- Valve 115	- Replace valve	
		- Over pressure lamp on	- Valve 115	- Check valve	
	4 V106 will not open	4 - 24 VDC at cut off valve 106	4 - Cut off V106 faulty	4 - Replace cut off valve	
		- O VDC at cut off valve 106	- Fuse 21	- Replace fuse	
		- O VDC at cut off valve 106	- Relay 25 MCP	- Replace relay	
		- O-VDC at cut off valve 106	- Relay 12 ICP	- Replace relay	
		- O VDC at cut off valve 106V	- PLC DST 3292 card	- Replace card	
		- >4mA at V106 ITP	- V106 ITP	- Replace ITP	
		- <3.5mA at V106 ITP	- PLC ASR 402 card	- Replace card	
		- >4mA at V106 ITP	- Valve 106	- Replace valve	

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

MAIN CONTROL & DATA ACQUISITION SYSTEM

PROBLEM/ SYMPTOM	FAILURE/ FAULT	DETECTION/ METHOD(S)	PROBABLE CAUSES	SOLUTION/ REMEDY	REMARKS/ REFERENCES
	5 V123 will not open	5 - 24 VDC at cut off valve 123 - O VDC at cut off valve 123 - O VDC at cut off valve 123 - O VDC at cut off valve 123	5 - Cut off V123 faulty - Fuse 5 - Relay 9 MCP - PLC DST 3292 card	5 - Replace cut off valve - Replace fuse - Replace relay - Replace card	
	6 V126 will not open	6 - 24 VDC at cut off valve 126 - O VDC at cut off valve 126 - O VDC at cut off valve 126 - O VDC at cut off valve 125	6 - Cut off V126 faulty - Fuse 6 - Relay 10 MCP - PLC DST 3292 card	6 - Replace cut off valve - Replace fuse - Replace relay - Replace card	
	7 V1 will not open	7 - 220 VAC at valve 1 - No voltage at valve 1 - No voltage at valve 1 - No voltage at valve 1 - No voltage at valve 1	7 - V1 faulty - Fused 16 - Relay 20 MCP - Relay 7 ICP - PLC DST 3292 card	7 - Replace V1 - Replace fuse - Replace relay - Replace relay - Replace card	
	8 V2 will not open	8 - 220 VAC at valve 2 - No voltage at valve 2` - No voltage at valve 2 - No voltage at valve 2	8 - V2 faulty - Fuse 17 - Relay 21 MCP - Relay 8 ICP	- Replace V2 - Replace fuse - Replace relay - Replace relay	

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

MAIN CONTROL & DATA ACQUISITION SYSTEM

PROBLEM/ SYMPTOM	FAILURE/ FAULT	DETECTION/ METHOD(S)	PROBABLE CAUSES	SOLUTION/ REMEDY	REMARKS/ REFERENCES
		- No voltage at valve 2	- PLC DST 3292 card	- Replace card	
	9 V3 will not open	9 - 220 VAC at valve 3	9 - V3 faulty	- Replace V4	
		- No voltage at valve 3	- Fuse 18	- Replace fuse	
		- No voltage at valve 3	- Relay 22 MCP	- Replace relay	
		- No voltage at valve 3	- Relay 9 ICP	- Replace relay	
		- No voltage at valve 3	- PLC DST 3292 card	- Replace card	
	10 Purge valve will not open	10 - 24 VDC at purge valve	10 - Purge valve faulty	10 - Replace V9	
		- No voltage at purge valve	- Fuse 8	- Replace fuse	
		- No voltage at purge valve	- Relay 12 MCP	- Replace relay	
		- No voltage at purge valve	- PLC DST 3292 card	- Replace card	
	11 V103 will not open	11 - 24 VDC at valve 103	11 - V103 faulty	11 - Replace V11	
		- No voltage at valve 103	- Fuse 3	- Replace fuse	
		- No voltage at valve 103	- Relay 7 MCP	- Replace relay	
		- No voltage at valve 103	- PLC DST 3292 card	- Replace card	
	12 V111 will not open	12 - 24 VDC at valve 111	12 - V111 faulty	12 - Replace V12	
		- No voltage at valve 111	- Fuse 4	- Replace fuse	
		- No voltage at valve 111	- Relay 8 MCP	- Replace relay	

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

MAIN CONTROL & DATA ACQUISITION SYSTEM

PROBLEM/ SYMPTOM	FAILURE/ FAULT	DETECTION/ METHOD(S)	PROBABLE CAUSES	SOLUTION/ REMEDY	REMARKS/ REFERENCES
		- No voltage at valve 111	- PLC DST 3292 card	- Replace card	
	13 Pump 2 will not turn on	13 - Pump 2 does not start	13 - Relay 3 MCP	13 - Replace relay	
		- Pump 2 does not start	- Contactor	- Replace ontactor	
		- Pump 2 does not start	- Overload trip	- Reset overload	
		- Pump 2 does not start	- Circuit breaker	- Reset cct breaker	
	14 Pump 3 will not turn on	14 - Pump 3 does not start	14 - Relay 2 MCP	14 - Replace relay	
		- Pump 3 does not start	- Contactor	- Replace contactor	
		- Pump 3 does not start	- Overload trip	- Reset overload	
		- Pump 3 does not start	- Circuit breaker	- Reset cct breaker	
	15 Compressor will not turn on	15 - Compressor does not start	15 - Relay 1 MCP	15 - Replace relay	
		- Compressor does not start	- Comp 1 contractor	- Replace contactor	
		- Compressor does not start	- Overload trip	- Reset overload	
		- Compressor does not start	- Comp 1 cct breaker	- Reset cct breaker	
	16 Heater will not turn on	16 - OVC at relay 16 wire 16	16 - Relay 16 MCP	16 - Replace relay	
		- OV at relay 3 wire 67	- Relay 3 ICP	- Replace relay	
		- OV at fuse 12 wire 67	- Fuse 12	- Replace fuse	
		- OV at relay 19 wire 19	- Relay 19 MCP	- Replace relay	

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

MAIN CONTROL & DATA ACQUISITION SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD(S)**	**PROBABLE CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
		- OV at relay 6 wire 70	- Relay 6 ICP	- Replace relay	
	16 Heater will not turn on	16 - OV relay at fuse 15 wire 70 - OVAC to thyristor drive - 380 VAC to thyristor drive - <3,5mA at heater cntl	16 - Fuse 15 - 380 V Input fuses - Thyristor drive - PLC ASR 402 card	16 - Replace fuse - Replace fuse - Replace drive - Replace card	
	17 Fan will not turn on	17 - OV at relay 15 wire 15 - OV at relay 2 wire 66 - OV at fuse 11 wire 66 - OV at relay 18 wire 18 - OV at relay 5 wire 69 - OV at fuse 14 wire 69 - OVAC to thyristor drive	17 - Relay 15 MCP - Relay 2 ICP - Fuse 11 - Relay 18 MCP - Relay 5 ICP - Fuse 14 - 380 V Input fuses	17 - Replace relay - Replace relay - Replace fuse - Replace relay - Replace relay - Replace fuse - Replace fuse	

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

MAIN CONTROL & DATA ACQUISITION SYSTEM				
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD(S)**	**PROBABLE CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
		- 380 VAC to thyristor drive	- Thyristor drive	- Replace drive	
		- <3,5mA at Fan cntl	- PLC ASR 402 card	- Replace card	
	18 Dow heater will not turn on	18 - OV at relay 14 wire 14	18 - Relay 14 MCP	18 - Replace relay	
		- OV at relay 1 wire 65	- Relpy 1 ICP	- Replace relay	
		- OV at fuse 10 wire 65	- Fuse 10	- Replace fuse	
		- OV at relay 17 wire 17	- Relay 17 MCP	- Replace relay	
		- OV at relay 4 wire 68	- Relay 4 ICP	- Replace relay	
		- OV at fuse 13 wire 68	- Fuse 13	- Replace fuse	
		- OVAC to thyristor drive	- 380 V Input fuses	- Replace fuse	
		- 380 VAC to thyristor drive	- Thyristor drive	- Replace drive	
		- <3,5mA at heater cntl	- PLC ASR 402 card	- Replace card	
	19 Dow pump will not start	19 - No voltage at dowtherm pump	19 - Relay 5 MCP	19 - Replace relay	
		- No voltage at dowtherm pump	- Relay 13 MCP	- Replace relay	
		- No voltage at dowtherm pump	- Fuse 1	- Replace fuse	
		- No voltage at dowtherm pump	- Fuse 9	- Replace fuse	

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

MAIN CONTROL & DATA ACQUISITION SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD(S)**	**PROBABLE CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
		- No voltage at dowtherm pump	- Relay 1 Dow Cntl	- Replace relay	
		- No voltage at dowtherm pump	- Relay 2 Dow Cntl	- Replace relay	
		- Pump trip lamp on	- Pump contactor	- Replace contactor	
		- Pump trip lamp on	- Pump overload	- Reset overload trip	
	20 Dow stirrer will not agitate	20 - No voltage at agitatot	20 - Relay 6 MCP	20 - Replace relay	
		- No voltage at agitator	- Fuse 2	- Replace fuse	
		- Agitator lamp on	- Stirrer contactor	- Replace contactor	
		- Agitator lamp on	- Stirrer overload	- Reset overload trip	
	21 All thermal valves dead	21 - PSU current limit LED's on	21 - 24 VDC short circuit	21 - Locate and correct	
	22 All vacuum valves dead	22 - No vacuum is formed	22 - Cct breaker trip	22 - Reset cct breaker	
	23 Heater and fan dead	23 - Thermal system temperatures	23 - Isolator trip	23 - Reset isolator	
		- Thermal system temperatures	- Cabinet switch off	Switch cabinet on	
	24 Dowtherm system dead	24 - Dowtherm system temperatures	24 - Isolator trip	24 - Reset isolator	

TROUBLE SHOOTING LIST FOR THE MEDIUM THERMO-VACUUM FACILITY

MAIN CONTROL & DATA ACQUISITION SYSTEM				
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD(S)**	**PROBABLE CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
		- Dowtherm system temperatures	- Cabinet switch off	- Switch cabinet on	
	25 Compressor and pumps dead	25 - No vacuum is formed	25 - V3E active	25 - Check 380V phase voltage	
	26 No update to XBTV terminals	26 - Error message on terminals - Error message on terminals - Error message on terminals	26 - Cable fault - Hardware error - PLC telway LED on	26 - Check cable - Contact supplier - Contact supplier	
	27 PLC dead	27 - No response from system - No response from system - No response from system - No response from system	27 - PLC "MEM" LED on - No PLC LED's on - No PLC LED's on - No PLC LED's on	27 - Reset PLC on front panel - Chedck PLC power supply - Check 220 VAC to PLC - Contact supplier	
	28 PC does not boot	28 - Display screen on - Display screen on - Display screen on - Display screen on - Display screen off	28 - PC PSU - PC CMOS set up - PC controller card - Command com missing - 220 VAC missing	28 - Contact suplier - Contact supplier - Contact supplier - Contact supplier - Check 220 VAC to PC	

DOWTHERM SYSTEM					
	PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
1	FAST DROP-PING OF DOWTHERM LEVEL	1.a - Dowthermal leak in system (thermal plate or pipework).	1.a - Smelling of the dowtherm. - Visual inspection.	1.a - Structural failure - Latent leak(s) open	1.a - Repair the structural damage or the leak(s)	
2	DOW-THERMAL FLUID DOES NOT REACH HIGH TEMPERA-TURE	2.a - Heater unit failure	2.a - No temperature rise in the Dow-thermtank or on the thermal plate.	2.a - Heater element failure - Electrical power supply failure. - Faulty control signal	2.a - Repair/replace the heater element. - Check the electrical power supply and repair if necessary. - Check the control signal, and repair if necesssary.	
3	DOW-THERMAL FLUID DOES NOT REACH LOW TEMPERA-TURE	3.a - Cooling system failure	3.a - No temperature drop on the thermal plate nor of the fluid (Dowtherm) inside the tank.	3.a - Faulty control signal - Contract valve failure (V115)	3.a - Check the control signal, and repair if necessary - Repair/reset or re-place valve.	
4	NO OR IN-SUFFICIENT RESPONSE OF THERMAL PLATE TEMPERA-TURES	4.a - Blocked pipes (Ice) 4.b - Incorrect valve setting.	4.a - Undetectable 4.b - Check valve to be closed V118.	4..a - Moisture in the system that iced up. 4.b - Incorrect signal from main control panel	4.a - Initiate heating cycle and maintain at 100°C for 2 hours. 4.b - Restore incorrect signal on the main control panel.	

DOWTHERM SYSTEM						
	PROBLEM/ SYMPTOM	FAILURE/ FAULT	DETECTION/ METHOD	CAUSES	SOLUTION/ REMEDY	REMARKS/ REFERENCES
				4.b - Incorrect position of manual valves - Damaged or broken valve	4.b - Adjust valve to correct position. - Replace damaged/ broken valve	
5	DOWTHERM SMELL IN WORKING AREA	5.a - Dowtherm leak in the pipework	5.a - Visual inspection to detect any leak(s).	5.a - Structural failure - Latent leak(s) open	5.a - Repair the structural damage or the leak(s)	

SECTION 6

DOCUMENTATION REFERENCE INDEX

1. INTRODUCTION

This section provides a quick reference documentation index, of all the catalogues as refered to in this manual. These catalogues are associated with the detail description, operation and maintenance of the individual components in subsystems of the Medium Thermo-Vacuum Facility.

DOCUMENTATION REFERENCE INDEX - MEDIUM THERMO-VACUUM FACILITY

SUB-SYSTEM	GROUP	ITEM DESCRIPTION REF TO P & ID	DOCUMENT DESCRIPTION	IST DOCUMENT NO	SUPPLIER CAT NO
VACUUM SYSTEM VTFM-20000-00	A Pre-evacuation Pumping System	1. Pump D40B Trivac rotary vane vacuum pump (P3)	Technical Data Operating instructions	VTFM-20000-128-01/1	LEYBOLD 171,2,02 11286
		2. Exhaust filter unit (EFI)	Technical Data	VTFM-20000-128-01/2	18916 GA01.29914
		3. Trivac-A	Catalogue	VTFM-20000-128-01/3	171.1.02
		4. Special adapter (A2)	Technical Data	VTFM-20000-128-01/1	16830
		5. Pump WSU 151 (P2)	Technical Data	VTFM-20000-128-02/1	11713 173.1.02
		6. Ads. TRAP FA30-60	Technical Data	VTFM-20000-128-01/1	18715
	B Ultra High Vacuum Pumping System	1. RPK 1500 U3 Cryopump (P1)	Operating instructions Technical Data Spare Parts List	VTFM-20000-128-03/1 VTFM-20000-128-03/2 VTFM-20000-128-03/3	GA771/4 89268 182.01.01 ET12.102/2
		2. Compressor RW2 (HCI)	Operating instructions Technical Data Operating instructions	VTFM-20000-128-03/1 VTFM-20000-128-03/2 VTFM-20000-128-03/4	GA771/4 182.01.01 89196
		3. Pressure hose FL9 (HSI)	Technical Data	VTFM-20000-128-04/1	89288 182.20.02
		4. RGD 210 (RHC)	Ordering Data	VTFM-20000-128-05/1	89220
		5. LT1 10 (LT11)	Ordering Data	VTFM-20000-128-06/1	89088
		6. Analog module (LT11)	Ordering Data	VTFM-20000-128-06/1	89097

DOCUMENTATION REFERENCE INDEX - MEDIUM THERMO-VACUUM FACILITY

SUB-SYSTEM	GROUP	ITEM DESCRIPTION REF TO P & ID	DOCUMENT DESCRIPTION	IST DOCUMENT NO	SUPPLIER CAT NO
	C. Pressure Measuring and controlling in-struments	1. Capsule Guage (DG1)	Ordering Data	VTFM-20000-128-07/1	16064
		2. Combitron CM 351	Operating Instructions Ordering Data Technical Data	VTFM-20000-128-08/1 VTFM-20000-128-08/2 VTFM-20000-128-08/3	GA09,503 15755 179.60.02
		3. Head PR35 (PEH 1)	Ordering Data	VTFM-20000-128-08/2	15751
		4. Head TR301 (PH1+PH2)	Ordering Data	VTFM-20000-128-08/2	15740
		5. 20 m Cable	Ordering Data	VTFM-20000-128-08/2	15756
		6. 20 m Cable	Ordering Data	VTFM-20000-128-08/2	15758
		7. 16KF VR 202 Viscovac tube	Ordering Data	VTFM-20000-128-09/1	15876
		8. PR Switch P113 (SVS 1)	Ordering Data Operating Instructions	VTFM-20000-128-10/1 VTFM-20000-128-10-2	16014 GA09.610/2
	D. Vacuum Valves	1. DN200CF Valve (V1)	Ordering cat. Operating instructions	VTFM-20000-128-11/1 VTFM-20000-128-11/2	28698 GA6.300 176.1.02
		2. DN100 ISO-F Valve (V3)	Ordering cat. Operating instructions	VTFM-20000-128-11/1 VTFM-20000-128-12/2	28646 GA06.302/3
		3. DN40KF Valve (V2)	Ordering Cat Operating instructions Spare parts list	VTFM-20000-128-11/1 VTFM-20000-128-13/1 VTFM-20000-128-13/2	28923 GA06.200/4 ET06.200/7

DOCUMENTATION REFERENCE INDEX - MEDIUM THERMO-VACUUM FACILITY

SUB-SYSTEM	GROUP	ITEM DESCRIPTION REF TO P & ID	DOCUMENT DESCRIPTION	IST DOCUMENT NO	SUPPLIER CAT NO
		4. DN40KF H Valve (V4)	Ordering Cat Operating instructions Spare parts list	VTFM-20000-128-11/1 VTFM-20000-128-14/1 VTFM-20000-128-14/2	28913 GA06.101/3 ET06.101/5
		5. DN10KF Leak Valve(V6)	Ordering Cat	VTFM-20000-128-11/1	28340
		6. 10KF Valve (V6)	Ordering cat	VTFM-20000-128-11/1	28720
		7. V13 Special DN40KF over pressure safety valve			
	E. Vacuum Seals, entering Rings, clamps and bellows	1. 200CF Cu gaskets	Technical Data	VTFM-20000-128-15/1	83947
		2. 35CF Cu gaskets	Technical Data	VTFM-20000-128-15/1	83943
		3. 16CF Cu gaskets	Technical Data	VTFM-20000-128-15/1	83941
		4. DN 250 Ultra Seals	Technical Data	VTFM-20000-128-16/1	88272
		5. DN 160 Ultra Seals	Technical Data	VTFM-20000-128-16/1	88271
		6. DN 100 Ultra Seals	Technical Data	VTFM-20000-128-16/1	88270
		7. DN 32/40KF UHV Seals	Technical Data	VTFM-20000-128-16/1	88377
		8. DN 10/16KF UHV Seals	Technical Data	VTFM-20000-128-16/1	88375
		9. DN 32/40KF UHV B/R	Technical Data	VTFM-20000-128-16/1	88378

DOCUMENTATION REFERENCE INDEX - MEDIUM THERMO-VACUUM FACILITY

SUB-SYSTEM	GROUP	ITEM DESCRIPTION REF TO P & ID	DOCUMENT DESCRIPTION	IST DOCUMENT NO	SUPPLIER CAT NO
		10. DN 10/16KF UHV B/R	Technical Data	VTFM-20000-128-16/1	88374
		11. DN 32/40KF UHV Clamps	Technical Data	VTFM-20000-128-16/1	88278
		12. DN 10/16KF UHV Clamps	Technical Data	VTFM-20000-128-16/1	88275
		13. UHV Sealing Disc DN63 ISOK	Technical Data	VTFM-20000-128-16/1	88267
		14. UHV Sealing Disc DN 100 ISOK	Technical Data	VTFM-20000-128-16/1	86730
		15. UHV Sealing Disc DN 63 ISOK	Technical Data	VTFM-20000-128-16/1	86729
		16. DN 63 ISOK Centering Ring	Technical Data	VTFM-20000-128-16/1	26807
		17. DN 100 ISOK Elbow (EB2)	Technical Data	VTFM-20000-128-16/1	88726
		18. DN 100 ISOK Bellow (B1)	Technical Data	VTFM-20000-128-16/1	88766
		19. DN 40 KF Bellow (B2)	Technical Data	VTFM-20000-128-16/1	86805
		20. DN 10 KF Centering ring	Technical Data	VTFM-20000-128-17/1	88321

DOCUMENTATION REFERENCE INDEX - MEDIUM THERMO-VACUUM FACILITY

SUB-SYSTEM	GROUP	ITEM DESCRIPTION REF TO P & ID	DOCUMENT DESCRIPTION	IST DOCUMENT NO	SUPPLIER CAT NO
		21. DN 10 KF Clamp	Technical Data	VTFM-20000-128-17/1	18341
		22. UHV Seals for small flange	Operating instructions	VTFM-20000-128-18/1	GA07.000
		23. Current leadthrough	Operating instructions	VTFM-20000-128-19/1	GA07.012

DOCUMENTATION REFERENCE INDEX - MEDIUM THERMO-VACUUM FACILITY

SUB-SYSTEM	GROUP	ITEM DESCRIPTION REF TO P & ID	DOCUMENT DESCRIPTION	IST DOCUMENT NO	SUPPLIER CAT NO
N2 Thermal System VTFM-30000-00	A Main components	1 Gas circulation fan	Maintenance manual	VTFO-30000-128-01/1	-
		2 Heater unit	Maintenance manual	VTFO-30000-128-01/1	-
		3 Cooler unit	Maintenance manual	VTFO-30000-128-01/1	-
	B Valves	1 Proportional control pneumatic needle valve (V109 and V106 and V115)	Technical data	VTFO-30000-128-02/1	Baumann Bulletin No 55-9
		2 Actuated ball valve (V103)			Worcester
		3 Isolation valve (manual) (V107, V104, V130, V131, V132, V135, V101, V102, V129, V128, V120, V118, V116 and V119)	Technical data for ball valves	VTFO-30000-128-03/1	Worcester 08164-G
		4 Propiortional control pneumatic ball valve (V112)	Technical data Technical data for pneumatic actuators	VTFO-30000-128-04/1 VTFO-30000-128-04/2	Worcester SB-442-13 Norbro series 40RSB
		5 Solenoid valve (V111, V126, V123 and V124)			Supplied by Ascoreg

DOCUMENTATION REFERENCE INDEX - MEDIUM THERMO-VACUUM FACILITY

SUB-SYSTEM	GROUP	ITEM DESCRIPTION REF TO P & ID	DOCUMENT DESCRIPTION	IST DOCUMENT NO	SUPPLIER CAT NO
		6 Thermal relief valve (V117; V108 and V105)			Supplied by APC Engineering
		7 Safety valve (V113)			Bestobell
		8 Non-return valve (V127 and V121)			Bestobell

DOCUMENTATION REFERENCE INDEX - MEDIUM THERMO-VACUUM FACILITY

SUB-SYSTEM	GROUP	ITEM DESCRIPTION REF TO P & ID	DOCUMENT DESCRIPTION	IST DOCUMENT NO	SUPPLIER CAT NO
CONTROL SYSTEM VTFM-40000-00	A CP-1 (Contol Panel)	1a PC (computer) manuals: hardware	- Owners Manual Volume 1 Volume 2	- VTFO-40000-128-01/1	386-25/33
			- 16 Bit ATA floppy/hard disk adapter Owners Manual	- VTFO-40000-128-02/1	8120A
			- View point NI VGA graphics adapter Owners Manual	- VTFO-40000-128-03/1	EV633
			- Microsoft Mouse Users Guide	- VTFO-40000-128-04/1	-
		1b PC Manuals software	- MS 0S2 Volume 1 Users Guide	- VTFO-40000-128-05/1	05/2
			Volume 2 Getting Started	- VTFO-40000-128-05/2	05/2
		2 PLC (programmable Logic controller)	- TSX7 model 40 programmable controller Installation manual	- VTFO-40000-128-06/1	TSX DM PR40E
			- TSX SCM 20/21/22 half/full duplex character mode	- VTFO-40000-128-07/1	TSX D 23 004E
			- Uni Telway Bus reference manual	- VTFO-40000-128/08/1	TSX D24 004E
			- TSX AEM 811 Analkog Input Module User's manual	- VTFO-40000-128-09/1	TSX D23 001E
				- VTFO-40000-128-09/2	W91262-952
			- TSX SUP 70 110/220 VAC 60W Power Supply	- VTFO-40000-128-10/1	-
			- TSX SUP 70 Alimentation 110/220 VCA - 50/60 Hz	- VTFO-40000-128-11/1	W91329-086

DOCUMENTATION REFERENCE INDEX - MEDIUM THERMO-VACUUM FACILITY

SUB-SYSTEM	GROUP	ITEM DESCRIPTION REF TO P & ID	DOCUMENT DESCRIPTION	IST DOCUMENT NO	SUPPLIER CAT NO
			- TSX MAP PC74 Mapway module	- VTFO-40000-128-12/1	TSX DM MAP
			TSX AST/ASR Analog Output module	- VTFO-40000-128-13/1	TSXD23007 E
			TSX SCM 21,6 voie 1 Bus UNI-Telway	- VTFO-40000-128-14/1	TSX D24005F
			TSX DST 3292 Interface Output Module	- VTFO-40000-128-15/1	W91262-975
			TSX DET 321232-Point 24 VDC input module service instruction	- VTFO-40000-128-16/1	W91262951
			PL7 operating modes under X-tel software workshop	- VTFO-40000-128-18/1	Telemecani-que
			X-tel software workshop base - standards tools	- VTFO-40000-128-18/1	Telemecani-que
			TSX MAP 1074 mapway module users manual	- VTFO-40000-128-19/1	Telemecani-que
			Mapway Network Reference Manual	- VTFO-40000-128-20/1	Telemecani-que
			XBT-VB8 Terminal	- VTFO-40000-128-21/1	Telemecani-que
			XBT-VB Terminal	- VTFO-40000-128-22/1	Telemecani-que
		3 Monitor 77	Monitor 77 Users manual	- VTFO-40000-128-23/1	-
			Monitor 77 Software manual	- VTFO-40000-128-24/1	-

DOCUMENTATION REFERENCE INDEX - MEDIUM THERMO-VACUUM FACILITY

SUB-SYSTEM	GROUP	ITEM DESCRIPTION REF TO P & ID	DOCUMENT DESCRIPTION	IST DOCUMENT NO	SUPPLIER CAT NO
Dowtherm thermal system VTFM-70000-00		1. Downtherm J heat trans-fer fluid	Technical Data	VTFM-70000-128-01/1	
		2. Dowtherm J fluid pump	Technical Data	VTFM-70000-128-02/1	